

central factor; but without doubt, subsidiary factors play important parts. Among the latter would appear to be excessive fatigue and concurrent respiratory infections of slighter degree, such as colds. That the unusual conditions surrounding the military life exert an influence at the outset is indicated by the circumstance that it is the fresh recruit and not the seasoned soldier who especially suffers from epidemic meningitis.

The source of meningitis in the Army and Navy is, in the first instance, the civilian population. Because healthy carriers of the meningococcus exist there, they have been introduced among the troops. Once there, they are menacing, apparently, according to fluctuating circumstances.

If we disregard, for the sake of our argument, the secondary factors that bear on the induction of infection, and concentrate attention on the meningococcus itself, two essential facts appear: first, that numbers of meningococci thrown off with the nasopharyngeal secretion, and second, that the bacteriologic type or variety of the organism play a large part in determining the result. Thus the healthy carrier who harbors many meningococci in his nasopharynx is relatively a much greater potential menace than the one who harbors few; and some types or varieties of meningococci are more pathogenic than others.

There is universal agreement among bacteriologists that the meningococci compose a complex group rather than a single, fixed type of micro-organisms. Recent studies also indicate that this group contains two immunologic varieties (so-called types) of meningococci which are responsible for from 75 to 80 per cent. of all cases of epidemic meningitis. The remainder of the cases are produced by meningococci of less fixed qualities and of less parasitic properties.

Studies of the meningococci among the general civilian population and military personnel, under conditions in which cases of meningitis are not frequent, show that the healthy carriers tend to harbor not the highly parasitic, but rather the less pathogenic varieties of meningococci. Once cases become frequent, however, the number of healthy carriers of the parasitic kind rises.

We are permitted, therefore, to view, tentatively at least, the class of meningococci somewhat as we now view the pneumococci. We distinguish among the latter parasitic and saprophytic varieties or types. The miscellaneous pneumococci composing the so-called Type IV group, notwithstanding the fact that certain ones may occasionally cause pneumonia, are still regarded as saprophytes and as practically always present in the mouths of a high percentage of normal persons. Similarly it may well be that normal persons not very infrequently carry the more saprophytic forms of the meningococcus.

Should we therefore proceed in the case of meningococcus as we have in that of pneumococcus, we should regard as menacing only the carriers of the parasitic varieties. Now, since in all our operations to conserve the health of our troops we must take into account the military exigencies, a distinction between dangerous and less dangerous meningococci would materially affect our practice of segregating meningococcus carriers and withdrawing them from active military training.

This distinction in types may now be readily made on the basis of specific agglutination with monovalent immune serums derived from rabbits. The subject, as

I have outlined it, is in its early stages. It is to be hoped that the experience of last winter in the Army and the Navy and the intrinsic importance of the matter will lead to a critical study of the meningococcus carrier problem from this point of view, in the hope and expectation that the control of epidemic meningitis may be made thereby simpler, more effective, and less disturbing to the training of our troops.

AN EXPERIMENTAL STUDY OF PAROTITIS*

MARTHA WOLLSTEIN, M.D.
NEW YORK

The subject of the etiology of parotitis has been investigated from a bacteriologic standpoint, and cocci have been isolated from the blood, saliva, and fluid aspirated from the swollen parotid gland.¹ Attempts to reproduce parotitis in animals by the inoculation of such cocci proved entirely unsuccessful, showing that these earlier studies had not solved the problem of the etiology of mumps. The cocci are probably contaminations. In 1908, Granata² first used saliva filtrate from parotitis patients for animal inoculation, suggesting that the virus of parotitis may be a filterable one. Since then investigators have tried to reproduce the disease in laboratory animals rather than to isolate a bacterium from human patients. Granata worked with rabbits; Gordon³ inoculated monkeys intracerebrally. Nicolle and Conseil⁴ injected material into the parotid glands of monkeys. The results of all these investigations were only suggestive as far as the reproduction of mumps in animals is concerned, and Gordon's attempts to transfer the disease from one monkey to another proved entirely unsuccessful.

Three years ago material was obtained in the following way from a number of children acutely ill with parotitis: The patients were allowed to rinse the mouth with sterile physiologic sodium chlorid solution, and the washings were filtered through a new Berkefeld candle N. The resulting filtrates were proved sterile by aerobic and anaerobic culture methods and were injected into the parotid glands and testes of healthy, half grown cats. During the past winter the prevalence of parotitis in Army camps near New York City provided the opportunity for repeating the work with material from adult (soldier) patients.⁵

EXPERIMENTAL

Cats were selected as the experimental animals because they are known to be subject to attacks of parotitis and it might reasonably be inferred, therefore, that they are not possessed of a natural immunity to the disease. Old cats proved unsuitable because the thick connective tissue on the side of the face over the parotids makes inoculation difficult, and such old

* From the Laboratories of the Rockefeller Institute for Medical Research.

* Read before the Section on Preventive Medicine and Public Health at the Sixty-Ninth Annual Session of the American Medical Association, Chicago, June, 1918.

1. Laveran and Catrin: *Compt. rend. Soc. de biol.*, 1893, **5**, 528. Busquet: *Rev. de méd.*, 1896, **16**, 744. Tessier, P., and Esmein, C.: *Compt. rend. Soc. de biol.*, 1906, **58**, Pt. 1, pp. 803, 853. McCray and Walsh: *Med. Rec.*, New York, 1896, **50**, 440.

2. Granata, S.: *Med. ital.*, 1908, **6**, 647-672.

3. Gordon, M. H.: Report to the Local Government Board on Public Health and Medical Subjects, London, 1914, N. S., No. 96.

4. Nicolle, C., and Conseil, E.: *Compt. rend. Acad. d. sc.*, 1913, **157**, 340.

5. I am indebted to Captain Meader for the privilege of obtaining material at Camp Mills; and to Captain Monaghan for many courtesies at the Army Hospital at Secaucus, N. J.

animals do not react well. Before anesthesia the temperature of the cats was recorded and the leukocytes counted and differentiated. The skin over the parotid and testis to be inoculated was denuded of hair and carefully cleansed. Injection with a new, sharp needle is not difficult. The parotid can be picked up between the point of the needle and the left index finger, and from 1 to 2 c.c. readily injected.

The animals recovered rapidly from the ether and showed no ill effects from the inoculations. The following day the temperature had usually risen 0.5 C., but the white blood cells had not increased in number. There was, as a rule, slight tenderness in the inoculated testicle, and often in the parotid as well. This was evidently of mechanical and not of inflammatory origin and always disappeared within another twenty-four hours, leaving the cats apparently well on the second day, although the temperature was from 0.5 to 0.8 C. above normal. After six or seven days tenderness returned in the testis, accompanied by swelling, and similar symptoms appeared in the parotid. An increase in the leukocytes became apparent two days after inoculation and reached the maximum in about seven to fourteen days, coinciding with the height of the fever. The swelling and pain in the parotid lasted from two to five days, but the testicular swelling rarely subsided in less than ten to fourteen days. In the third week all the symptoms began to disappear, the leukocytes reaching the normal first, the tenderness disappearing at the same time, and the fever persisting for another week. While tenderness on palpation of the parotids was less marked than that of the testes, and the swelling never reached the stage of marked facial asymmetry, the cats manifested some degree of discomfort in the inoculated parotid. The appetite was only slightly affected, and at no period of the experiments did the cats seem especially ill. The disease was not fatal in any instance. Animals killed late in the second or early in the third week showed swelling of the inoculated parotid as well as of the other salivary glands and the neighboring lymph nodes.

The salivary filtrates from patients ill from one to three days produced these marked symptoms in the inoculated cats (Fig. 1). On the sixth day of the disease the effect of the filtrate injection was much less marked, and inoculation of material obtained from a patient nine days or longer after onset of the mumps attack was apparently without result: that is, the cats showed a temperature range of only 0.5 C., the leukocytes were not even doubled in number, and the mononuclear cells were not increased, but the polymorphonuclears were. At necropsy the parotid and the adjacent salivary glands and lymph nodes showed neither gross nor microscopic changes. It would seem, therefore, that the infective period of the mouth secretions from parotitis is comparatively short, lasting about a week and corresponding to the period of swelling of the parotid gland. A fresh swelling appearing in the opposite parotid gland would naturally prolong the infectious period for a given patient.

TRANSMISSION FROM CAT TO CAT

Transmission from cat to cat was accomplished in two ways: by means of the saliva of the inoculated cats, and with emulsions made from the inoculated glands.

By anesthetizing the animals, large amounts of ropy saliva were obtained, and at the height of the symp-

toms, at the end of the second week after inoculation, the cats were found to harbor in their mouth sufficient virus to produce active symptoms in normal cats. Salivary secretions from normal cats were used as controls and gave only negative results, just as did normal saliva from healthy human beings.

Emulsions from the inoculated glands were made by grinding the organs in a small, tissue-grinding machine, through whose fine wire screen from 0.2 to 0.3 c.c. of finely divided material passed. The best time for the reinoculation was found to be from the fourteenth to the seventeenth day, when the testicular swelling, the leukocytosis and the fever were highest. During the first seven to ten days, transfers were less uniformly successful. Evidently the reaction requires about two weeks for its maximum development. Atrophy of the inoculated testicle occurred in several cats, after the acute symptoms had abated.

After the third or fourth transfers, the reaction developed more rapidly and the effects were more severe. But after the sixth or seventh transfers, the reaction perceptibly declined.

These experiments were controlled with extracts prepared from the parotid glands and testicles of normal cats. The inoculation of such normal extracts was followed by a slight rise in temperature lasting only two days, and a polymorphonuclear leukocytosis of the same duration. No enlargement nor tenderness developed in the inoculated glands and at necropsy no changes were demonstrable in them.

PATHOLOGY

1. *Gross Appearance.*—(a) *Parotid Gland:* The inoculated parotid was deeper pink and larger than the uninoculated gland. This difference was often striking. It was also more moist than the uninoculated side and showed on section a granular appearance due to swelling of the acini. The submaxillary and the sublingual glands, as well as the adjacent lymph nodes, were congested and distinctly enlarged. The molar gland, lying just beneath the skin at the angle of the mouth and extending along the lower lip, was uniformly congested and swollen on the inoculated side. During life the buccal mucosa over the gland was distinctly reddened. This symptom could be found in the cat's mouth in four or five days after inoculation. The opening of the duct leading from the injected parotid was always surrounded by a small zone of congestion.

(b) *Lymph Nodes:* The lymph nodes on both sides were decidedly swollen and moist, especially the two nodes close to the anterior border of the parotid. The smaller nodes along the posterior border were usually more swollen on the inoculated than on the uninoculated side.

(c) *Testis:* The inoculated testis was larger than the uninoculated, but unchanged in color. On section the cut surface was more gray, cloudy and moist. In a few instances the point of inoculation was visible as a small dark spot, but otherwise no focal changes were noted.

2. *Microscopic Appearance.*—(a) *Parotid:* The histologic changes present in the parotid were usually inconspicuous in the first transfer, and consisted only of congestion of the vessels and swelling of the epithelium of the acini, with edema of the interlobular connective tissue. These are the changes that have been described in the pathology of human mumps.

In the third and fourth transfers, the glands often showed infiltration of the interlobular connective tissue, with mononuclear and a few polymorphonuclear cells in addition to the edema. The infiltration was most intense about the secretory ducts, which were sometimes dilated (Fig. 2). The epithelium of the acini was swollen and cloudy in some instances. The areas

20,000, and a daily variation of 5,000 not an unusual event; consequently, only decided increases can be of significance. In the inoculated animals the white cells began to increase within the first forty-eight hours, while on the seventh and eighth days a sudden additional rise, often doubling the initial count, may occur. The increase is maintained, with daily fluctuations, for a period of from eight to ten days, the maximum being reached on about the fourteenth to the sixteenth day. The fall takes place gradually, the initial number being reached, as a rule, in about four weeks. During the first two weeks the leukocytosis is polymorphonuclear in character. At the end of the second or beginning of the third week, when the fever and glandular swellings are at the highest, a lymphocytosis is noted. The large mononuclear and eosinophil cells remained practically unchanged throughout.

The blood picture as described in the experiments is not dissimilar from the one observed in cases of parotitis in man with testicular complications. The increase in mononuclear cells found by Nicolle and Conseil⁴ in one of their monkeys, which had been inoculated into the parotid but not into the testicle, is of some interest in this connection, as is the polymorphonuclear leuko-

cytosis without the later appearance of a lymphocytosis noted in cats inoculated intratesticularly with material from normal cats, as controls; that is, the characteristic thing in the blood picture during parotitis is a mononuclear cell increase.

2. *Virus Content.*—The marked constitutional symptoms noted in many parotitis patients suggested an investigation of the blood at the height of an attack.

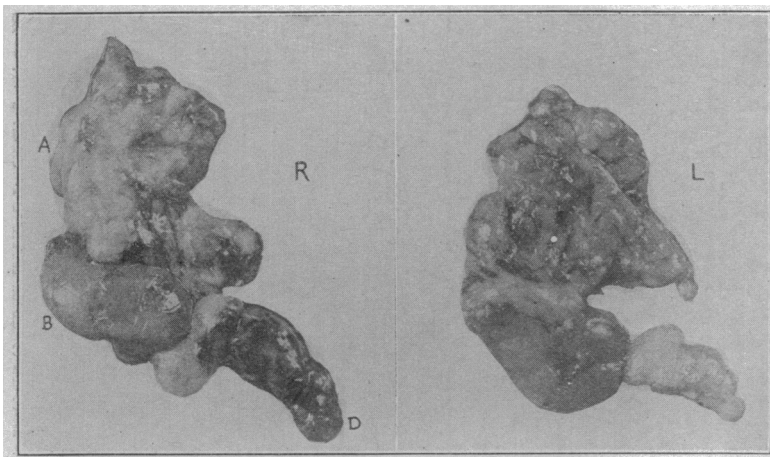


Fig. 1.—Parotid, submaxillary and sublingual glands and adjacent lymph nodes showing swelling of the inoculated (right) side; cat killed after seventeen days: R, right; L, left; A, parotid gland; B, submaxillary gland; D, lymph nodes.

of cellular infiltration were more pronounced in some parts of the gland than in others, were always multiple, and could be easily differentiated from the small lymph nodes normally present between the lobules.

(b) *Testis:* The histologic changes in the testis were more constant than those in the parotid, and more pronounced in the epithelium than in the supporting framework of the gland. The layer of cells next to the basement membrane of the tubules tended to be normal in appearance, but the rest of the cells were often the seat of a change resulting in a diminution in the number of spermatocytes and consequently of the mitotic nuclei normally found. The spermatids were still more altered, showing as the remains of their nuclei irregular and deeply staining granules, while the cell bodies stained poorly or had undergone extensive lysis. As would be expected, spermatozoa were diminished in number, and few were normal in appearance, their broken-up condition being easily discernible. Epithelial changes of some degree were present in some part of practically all the inoculated testicles. Interstitial cellular infiltration, on the other hand, occurred far less frequently in the testicle than in the parotid gland. Another striking change in the testis was noted in the interstitial cells. These were larger than normal, and, in several instances, actually increased in number, forming large masses between the tubules.

(c) *Lymph Nodes:* On microscopic examination, the swollen lymph nodes showed necrosis of the center of several lymph nodules, while the sinuses were distended and the lining cells swollen.

BLOOD CHANGES

1. *Leukocytes.*—The average number of leukocytes in the normal cat was found to be from 16,000 to

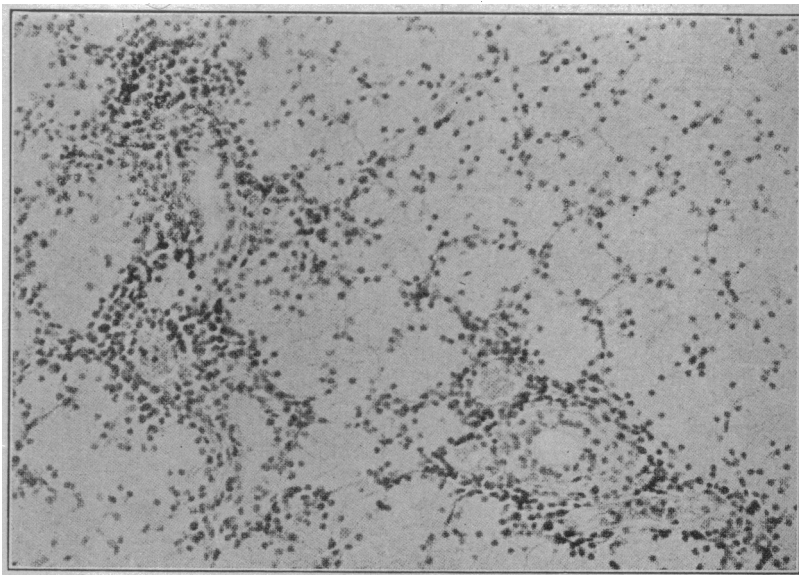


Fig. 2.—Parotid gland, showing cellular infiltration around the secretory ducts; cat killed after eighteen days.

Films were found to be negative for parasites and bacteria, and cultures made both aerobically and anaerobically remained sterile. Blood was taken from a vein at the elbow in seven patients ill from two to three days. All showed marked constitutional symptoms. The blood was defibrinated, proved to be sterile, and then inoculated into normal cats. Control animals were inoculated with

blood from a normal adult. The results were interesting. While the temperature range was not high, it was least high in the controls. The blood count, on the other hand, showed a polymorphonuclear leukocytosis in both sets of animals; but while the mononuclear cells were diminished in the control cats, they were actually increased throughout in the animals receiving the blood from the patient ill of parotitis. The blood taken from a case with slight symptoms on the fifth day of illness gave no result on injection into a cat.

The conclusion drawn from these experiments is that the blood of parotitis patients, especially when suffering from severe constitutional symptoms, is infective for cats. This conclusion is in keeping with the clinical course and metastatic complications of certain cases. Figure 3 shows the swollen glands in a cat inoculated with the blood of a patient.

PROTECTION EXPERIMENTS

Results suggesting that protective substances may be developed by the cats after they have passed through a typical attack of experimental parotitis were obtained in two ways: 1. Animals were reinoculated from one to four months after the first inoculation and failed to develop the typical symptoms they had previously exhibited. 2. As was to be expected from the results of these reinoculation experiments, the serum from recovered cats had the power to reduce the development of the reaction caused by the injection of the virus of parotitis when left in contact with it at 37° C. for two hours. Animals inoculated with such a serum-virus mixture failed to develop the typical symptoms or lesions produced by the virus alone or by virus treated with normal cat serum.

RECURRENT CASE

An interesting recurrent case occurred in a soldier. His first attack of mumps began in November, 1917, and he had three recurrences, the last one early in May, 1918. March 13 and again, May 1, his filtered saliva was injected into a cat, with positive results. Figure 4 illustrates the lesion caused by the filtrate of his saliva during the second recurrence. May 15, the mouth secretions were found to be negative and the facial swelling had disappeared. Jochmann⁶ says that the swelling of the parotid may remain for months or even a year. The lesion in this soldier lasted for a period of five and a half months, and his saliva was infectious for that period.

SUMMARY

Cats injected into the parotid gland and testicle with a bacterial sterile filtrate of the salivary secretion of children and adults in the active stage of parotitis or

mumps develop a pathologic condition resembling the condition present in mumps in human beings.

After an incubation stage of from five to eight days, definite changes have been noted in the temperature, blood leukocytes, and inoculated organs.

The rise of temperature and the leukocytosis precede the glandular swelling, but all the changes reach the maximum at about the same time, after which they decline, and normal conditions are reestablished in about four weeks.

The intraparotid and intratesticular injections of extracts of normal parotid gland and testicles may cause a mild rise of temperature and leukocytosis of brief duration, but swelling and tenderness are absent. The white cells increased are the polymorphonuclears and not the lymphocytes. The injection of filtrates of normal saliva causes only a mild and brief rise of temperature, but no leukocytosis nor swelling of the glands.

The saliva of man and of inoculated cats as well as the inoculated glands of the latter animals were found to contain the filterable infective agent.

The virus of parotitis is most readily detected in the saliva during the first three days of the disease, less readily on the sixth day, and not at all after the ninth day. This would have a practical bearing on the question of infectivity and length of isolation period for mumps patients.

The virus was also detected in the blood of patients showing marked constitutional symptoms.

The serum of recovered cats was found to contain an immune body which diminished or even neutralized the action of the virus of parotitis.

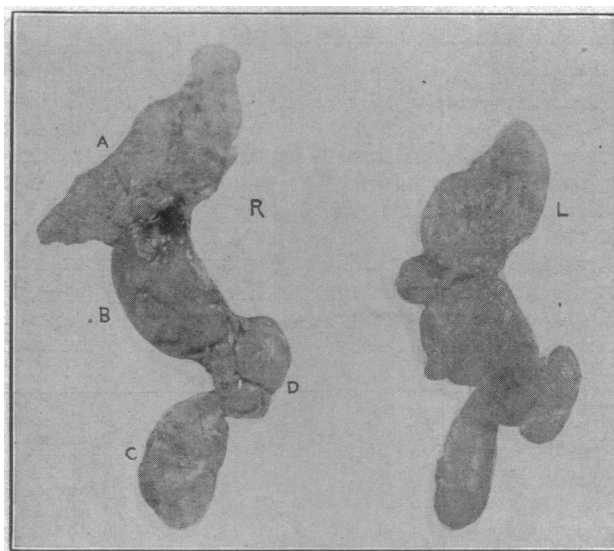


Fig. 3.—Parotid, submaxillary and sublingual glands and adjacent lymph nodes, showing swelling of the right side inoculated with blood from a patient ill three days; cat killed after seventeen days: R, right; L, left; A, parotid gland; B, submaxillary gland; C, sublingual gland; D, lymph nodes.

ABSTRACT OF DISCUSSION

COL. FREDERICK F. RUSSELL,
Washington, D. C.: It is appar-

ent from these charts that the respiratory infections run similar curves and that in general city populations are immune and country populations are not immune; that the spread of measles, particularly, seems bound to take place when the men are brought together. If measles does not appear early, it will probably occur later, when the troops are crowded. We must remember that they are going to be crowded on the way across the Atlantic and on the other side; that there will be less air space per man over there than there is here in our own camps. As it seems almost inevitable that the men will have measles, it is better for them to have the disease under the best circumstances. The immunity that the city troops have to all the respiratory infections gives a hint of the remedy needed to make country troops equal to city troops. The diseases for which we have good vaccines have not appeared on these charts, and this again shows the importance of an active immunity against acute respiratory infections.

These are the causes of death—pneumonia, meningitis, traumas, tuberculosis, measles, scarlet fever, diphtheria, typhoid and paratyphoid. Smallpox is not even on the chart, so it is apparent that these diseases, for which we have pretty good protection, are not important. It is measles, meningitis

6. Jochmann, G.: *Lehrbuch der Infektionskrankheiten*, Berlin, 1914.

and pneumonia of various kinds that cause the great mortality. We have now a new incentive to look for some way of producing artificial immunity against these diseases. So far as lobar pneumonia is concerned, it seems probable, from the work of Lister in South Africa and Cole in New York, that we have a vaccine which promises good protection against lobar pneumonia. Unfortunately, there is nothing very promising for these other infectious diseases, but it seems apparent that in order for us to have seasoned troops we have got to have immune troops, either immune as the result of naturally acquired disease or immune as the result of some sort of vaccination.

DR. WILLIAM C. RUCKER, U. S. Public Health Service, Washington, D. C.: I have just returned from France, where, under the direction of the Chief Surgeon of the American Expeditionary Forces, an investigation was made relative to the sanitation of the troops in transport. I am not at liberty to give you the accurate data regarding the findings because to do so would be to disclose the number of troops that have moved and the ports by which they entered Europe. In one instance of a single convoy, on which there were not quite 14,000 troops, the time of the voyage was fourteen days. Of these troops thirteen men died before shore was reached. Of these thirteen deaths nine were due to pneumonia, three to acute tuberculosis and one to acute cardiac dilatation. There were 235 admissions to the sick bay during the fourteen-day voyage, of which 114 were discharged to the hospital when the troops were disembarked. The remainder were either returned to duty or were among the thirteen who died. There were forty-four cases of pneumonia; I forget the number of cases of mumps, but there were a considerably greater number of cases of mumps, and when we exclude the venereal diseases, there was only one case, a case of acute cardiac dilatation, which was not a sputum-borne disease. The greatest number of admissions to the sick bay was on the sixth day of the voyage. From that I think it is pretty safe to assume that the infections were acquired prior to embarkation. The sanitary condition of the vessels was excellent in every case. The Navy has handled that end of the work remarkably well, and in no case was there infection which was traceable to the ship itself. We have control of the fecal-borne infections and we must focus our attention in the future more on the sputum-borne infections. The best way to accomplish this, so far as transportation is concerned, is to quarantine troops very carefully and to repeatedly examine them prior to embarkation, so that the sick man may not be shipped to Europe. The Surgeon-General's Office has handled this end of the problem remarkably well. There are some faults in the system at the present time, but they are not the faults of the medical department.

COL. V. C. VAUGHAN, Washington, D. C.: I made a study of pneumonia and other communicable diseases in the camps during the six months from October 1 to March 31 and found that there are great differences in morbidity and mortality rates in the different camps. The healthiest camp was that of the Illinois National Guard, located at Houston, Texas. The death rate in this division was in round numbers one-half the death rate in the same age group in Chicago for the same time. The healthiest camps were located in the South

and were occupied by northern troops. The next healthiest troops were northern soldiers in northern camps. The highest death rates were found with southern troops in southern camps. There were three camps with a death rate above 24 per thousand, and deaths were mostly due to pneumonia. These camps were Pike in Arkansas, Beauregard in Louisiana and Wheeler in Georgia, all occupied principally by southern troops. When we take a map and place the camps not where they are, but in the center of the area from which the troops came, we find that all the good camps are in one area, and that area is the northern part of the United States, east of the Mississippi River. It appears, therefore, that the prevalence of pneumonia depends on the susceptibility of the individual, and that southern soldiers are much more susceptible than their northern comrades. This was true in the Civil War, and apparently continues up to the present time.

The Surgeon-General himself having had large experience with pneumonia both on the Panama Canal zone and in South America, recognized the fact that the respiratory diseases would be those with which we would have to contend, and in order to limit the spread of these diseases, he insisted on proper floor space in barracks. It has developed that when we speak of crowding in our Army camps, we are prone to think only of sleeping quarters. Crowding in camps occurs

more frequently and more dangerously in waking hours than it does in sleeping hours. When men gather around the stove in barracks or when they go to a place of amusement or instruction, there is the greatest and most dangerous crowding. Major Soper has figured out that at Oglethorpe, in a large amusement hall, when it is filled, if every man sits perfectly upright and does not move his head one way or the other, the greatest possible distance between one man's nose and that of another man on the same row would be 16 inches, and that on the

rows in front and behind would be 26 inches. When one leans over and coughs, and when you think of 9,000 men sitting in such a hall and two thirds of them cough at once, you can see what it means.

So far as I know, in only one camp has there been any careful examination for malaria, and the percentage found in that camp was less than two. Of course, this does not prove that only 2 per cent. of the soldiers in this camp had malaria or had ever had this disease. At Bowie, in Texas, a thorough examination was made for hookworm, and about 12 per cent. of the soldiers were found to be infected. It seems from these figures that neither hookworm nor malaria has existed in the southern camps to the extent generally supposed.

DR. H. GIDEON WELLS, Chicago: We have heard something about the situation as to cholera on the Macedonian front. It may be interesting to mention the Roumanian front on the opposite side of Belgium. At the time of the retreat of the Roumanians into Moldavia there was suddenly crowded there a double population, with few roofs to cover them and very little food. Consequently, the population was moving as rapidly as possible and as freely as possible to get food and shelter. Cholera immediately broke out and, under these conditions, at once spread widely, with no possible means of preventing it by quarantine. Professor Cantacuzene of the University of Bucharest had brought out their bacteriologic laboratory equipment on cars. They at once established as

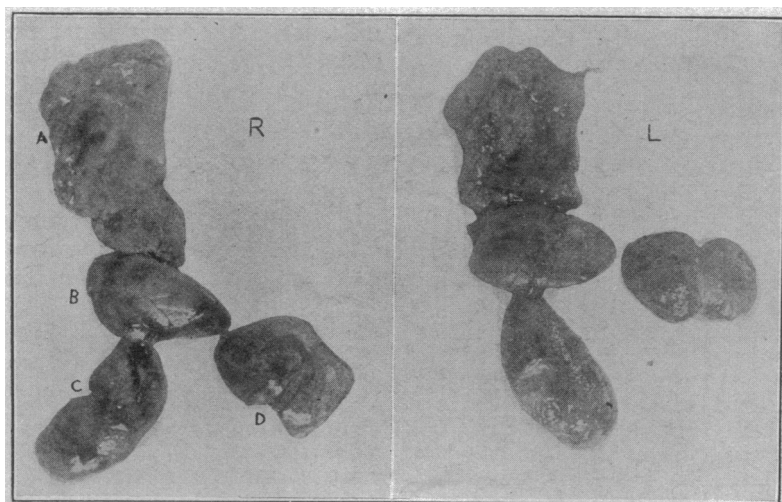


Fig. 4.—Parotid submaxillary and sublingual glands and adjacent lymph nodes, showing swelling of the right side inoculated with saliva filtrate from a recurrent case; cat killed after fifteen days: R, right; L, left; A, parotid gland; B, submaxillary gland; C, sublingual gland; D, lymph nodes.

near universal vaccination as possible. There was absolutely no other way to interfere with the spread of cholera, yet there was practically not a case remaining in less than two months. Last summer, at certain of the camps, all the men passing through these stations were examined as to the existence of cholera carriers, and there were no cases to be found among these troops, showing how efficient cholera vaccination is by itself, even in the absence of proper quarantine and sanitation.

DR. PAUL ARMAND-DELILLE, France: Our French laboratories had the same experience. There were some cases in the civilian population, and in Corfu they used the same method, vaccination, and stopped the epidemic.

DR. SIMON FLEXNER, New York: I was asked to touch on the point of the extent to which examination should be made in the search for meningococcus carriers. In the first place, I should say that whole commands should not be swabbed. Even assuming the operation practical, it would not be justified. I approve the plan outlined in the leaflet of information of meningitis issued by the Surgeon-General of the Army, in which the Navy concurs. This plan is based on wide experience. Briefly, it consists in swabbing first the close associates of the case of meningitis, and later extending and widening the circle according to circumstances—that is, whether more cases arise or not. Two advantages are obtained by this procedure: disorganization of the military personnel is avoided, and the carrier work is done more thoroughly and with greater finality. To attempt to swab organizations larger than the laboratory force can handle well is either to invite inaccurate reports or to compel repetition of the work.

COL. FREDERICK F. RUSSELL, Washington: There was one point about the carrier work which has been done on meningitis which shows in the survey of all the camps, and that is that where the carrier work was done thoroughly at the beginning the disease never became widespread, nor has it persisted. In some of the camps, where for one reason or another it was impossible to get the carrier work started early until the cocci and the infection were widespread through the camp, we have not been able to get the rate down, and at the end of the year we find certain camps have had a much higher number of cases than other camps, and they are the camps which were late in getting to work on the carrier problem.

DR. RUFUS COLE, New York: It is remarkable that there has been little or no pneumonia among English and British troops. The factors on which this freedom from pneumonia depends is still somewhat obscure. Dr. Vaughan has brought out the extremely important fact that racial or geographic immunity does really exist entirely apart from other conditions, such as climatic or hygienic ones. However, there are two main factors to be considered in infections. Individual resistance is one of these factors, but the virulence or invasiveness of the infectious agent is also of significance.

Monkey Bone Grafts.—Küttner recently reported in the *Münchener medizinische Wochenschrift*, 1917, No. 45, the present status of two children who had had the lacking fibula or radius replaced with the corresponding bone from a young macacus monkey. The children were 9 months and nearly 2 years old at the time, and the interval since has been six and four years. The roentgenograms show that the bones have grown solidly in place but there has been no growth in length. This experience shows that living bone is available in this way for implants, and that possibly whole joints, tendons and vessels from apes and monkeys might be utilized, but Küttner doubts whether monkey nerve tissue would ever be suitable for grafting. (From an abstract in the *Nederlandsch Tijdschrift*.)

CHANGES IN THE BRAIN IN GAS (CARBON MONOXID) POISONING*

EMORY HILL, M.D.

AND

C. B. SEMERAK, M.D.

CHICAGO

This subject is important for three reasons:

1. Carbon monoxid is liberated by bursting shells and therefore is one of the gases responsible for mortality in the present war.

2. Deaths, accidental and suicidal, from inhalation of illuminating gas are increasingly frequent in civil life.¹ Henderson² states that carbon monoxid causes more deaths than all other gases combined. There is a reason to believe that a higher carbon monoxid content in illuminating gas is in part responsible for this. Statistics of certain cities of Great Britain³ indicate that the higher percentage of such deaths parallels the greater proportion of water gas used in the manufacture of a cheaper product.

3. Carbon monoxid poisoning is of medicolegal significance. A history is not always available, and the characteristic cherry-red color of the blood and chemical

proof of carbon monoxid are aids to diagnosis only in the first few days after poisoning. Kolisko⁴ in 1914 maintained that carbon monoxid produces invariably a characteristic lesion in the brain, namely, bilateral softening of the lenticular nucleus. We have attempted to discover whether this observation can be confirmed.

The present study consists of the examination of

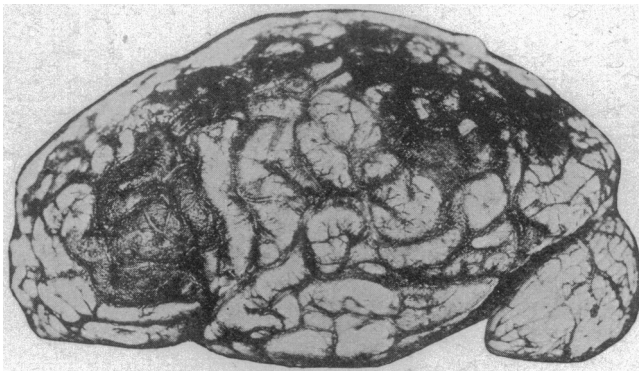


Fig. 1.—Extensive hemorrhages in the leptomeninges in gas poisoning.

thirty-two brains obtained from the postmortem rooms of the Cook County Hospital. In every case the clinical record and complete necropsy report have been available for correlation with the pathologic condition found in the brain. The fresh brains were described on removal, hardened in 10 per cent. dilution of solution of formaldehyd, and again described. Thin cross-sections made by cutting the brain transversely at right angles to the anteroposterior axis were then described. Blocks were removed regularly, including the leptomeninges and cortex from the lateral surface of the hemispheres, corona radiata, centrum semiovale, corpus callosum, lenticular nucleus and internal capsule, pons, medulla and cerebellum. Other areas were selected where gross changes were evident. The blocks

* Because of lack of space, this article is abbreviated in THE JOURNAL by omission of the case reports. They will appear in the reprints, a copy of which will be sent by the authors on receipt of a stamped, addressed envelop.

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