The disinfecting apparatus allows the production of steam which contains a certain amount of liquid disinfecting agent. I first compared the composition of the steam with the concentration of the liquid. It would lead us too far if I should give details of the numerous experiments I made for that purpose. I shall only mention briefly that the effective substance contained by the steam by no means always corresponds with the concentration of the solutions; indeed, their relations are sometimes very complicated.

Formaldehyd being the cheapest of all the means which I tried, I always used it for my experiments. Christian found by means of different experiments on the killing of anthrax spores that at 50 C. the best results are obtained if 8 per cent. solutions are evaporated, which means that the steam contains from 2 to 8 per cent. of formaldehyd. The spores are killed in the same time as in saturated steam of 100 C. With my method little formaldehyd is lost, as the steam and the formaldehyd can be condensed and pumped back to the boiler. Strong pneumatic pumps empty the disinfecting apparatus in a short time until the desired vacuum is attained.

By steam-formaldehyd disinfection even the most delicate objects are not injured. At present the method has been carried to such a pitch of technical perfection that large apparatus in which even whole invalid-carriages can be disinfected are in use. Steam disinfection may now be used for all those objects to which it could not be applied formerly, and it kills not only the vegetative forms of microbes but also all living germs. It is possible to construct a large apparatus for the disinfection of railway cars. The trouble is little, and even the most luxuriously furnished car is not injured, while all living germs are killed. It would mean a great advance in railway hygiene if much-used cars, chiefly sleeping-cars, could be disinfected now and then. It is certain that progress will be made in this direction. Formaldehyd will not always remain the only means of disinfection; for instance, Christian found that thymol might be used as well for the apparatus; but formaldehyd being the cheapest means up to the present, it is the best for practical use.

It would be of great value to provide railway stations at the frontiers with better disinfecting apparatus. They might be useful, not only in the case of epidemics, but for the disinfection of infectious goods; I am thinking of the anthrax danger. Nowadays, infectious goods are sent to the stations which are responsible for their disinfection. This is always a danger because of the possible dissemination of infectious germs. I believe that these new methods of disinfection will help us in many cases in which the former methods were not applicable.

I hope I have proved that theory and practice must work together, and that scientific analysis is not only necessary for practical work but may even indicate new ways toward its improvement.

Fish to Destroy Mosquitoes.—An interesting experiment is being tried in South Africa, with the object of combating malaria. The officer in charge of the government fish hatchery in the Cape Province is now arranging to introduce from the Barbados a quantity of the small fish known as "millions." These tiny fish are said to have kept the Barbados Islands free from malaria by destroying the larvae of the fever-carrying mosquito. Two large ponds have been prepared for the reception of the fish, which are to be propagated and distributed throughout the fever districts of South Africa.—*Australasian Med. Gaz.*

A POSSIBLE SOURCE OF DANGER IN THE USE OF ANTIMENINGITIS SERUM*

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Dr. A. L. Knight of Madisonville, Ohio, asked me to see a case of meningitis with him March 5, 1913. We found a boy, aged 6, who had had intense headache, fever and nausea for three days. The head was markedly retracted and the neck rigid; Kernig's sign was present. The child was immediately sent to the private ward of the Contagious Hospital. Thirty c.c. of turbid cerebrospinal fluid were withdrawn, in which the meningococcus was subsequently found, and 30 c.c. of antimeningitis serum were injected with very good effect.

The following morning Dr. Knight sent the child's sister, aged 2, to the hospital with similar symptoms. This child immediately received the same treatment. In this case, however, the cerebrospinal fluid was clear, and no meningococci were found.

Fig. 1.—Section of cord of new-born child from the region of the conus medullaris, showing the passage leading from the central canal through the posterior median fissure to the outer surface. Top, anterior surface; bottom, posterior surface; C, central canal lined with ciliated epithelium.

The second child improved rapidly after the treatment, so that by March 9 we thought of sending her home. She was afebrile, with no headache, the only symptom being a retention of urine. The following morning she had a temperature of 102 with headache, rigidity and Kernig's sign positive. At 11 a. m., March 10, 30 c.c. of clear cerebrospinal fluid were withdrawn under light anesthesia, and 20 c.c. of antimeningitis serum injected. The child received no anesthetic during the time of injection. About two minutes after the injection she suddenly stopped breathing and became livid, the pupils being contracted, the heart beating strongly. After three minutes of artificial respiration the child again breathed normally and showed an internal strabismus of the right eye due to a paralysis of the right external rectus. An hour after, when the child became conscious, the nurse noticed a hemiplegia involving the

*Presented to the Clinical Society of the Cincinnati Hospital, March 20, 1913.

entire left side of the body. The paralysis of the leg and face and right rectus disappeared that day. The left arm remained slightly paralyzed up to the time of the child's death, March 17. The day following the injection, the child developed a marked urticaria and a consolidation of the left lung due to a pneumonia, which proved fatal a week later.

At the time of the second injection the cessation of respiration and the nuclear paralysis struck me forcibly as being similar to what occurs in those patients who die after the lumbar subdural injection of cocaine for purposes of anesthesia. The child's nurse, Miss Augusta Miltz, told us that she had seen three immediate deaths following the administration of antimeningitis serum at the Cincinnati Hospital last year. On going over the records these cases were found and will be given.

A child, aged 10 months, with a marked bronchitis, was admitted to the service of my colleague, Dr. A. Friedlander, at the Cincinnati Hospital, March 12, 1913, at 2 p. m. The child's head was retracted, and Kernig's sign was present.

At 2.30 p. m. by spinal puncture 20 c.c. of cerebrospinal fluid containing some accidental blood were obtained. No anesthetic was used, the child crying during the slight operation. Twenty c.c. of New York Board of Health serum were then slowly introduced; the injection consumed at least twenty minutes.

At the end of the injection the child ceased crying and the respiration ceased. The pulse was good. Five c.c. of fluid were allowed to escape from the needle. Artificial respiration was immediately instituted; a facial paralysis of the right side developed and after two minutes the child was dead.

The coroner's autopsy in the case showed an extensive catarrhal pneumonia, some fluid at the base of the brain, no pus or fibrin in the cerebrospinal fluid, and no meningococcus.

A colored male child aged 4 was admitted to the service of Dr. Friedlander at the Cincinnati Hospital, March 12, 1913, with a temperature of 104, pulse 124, respiration 70, a bronchopneumonia, rigidity of the neck and an intermittent Kernig sign.

Spinal puncture was made, March 14, at 11 p. m., and 20 c.c. of cloudy fluid obtained. The fluid contained numerous leukocytes and a large number of Gram-negative intracellular diplococci. At midnight 10 c.c. more fluid were removed and 30 c.c. of New York Board of Health serum slowly injected. The injection consumed fifteen minutes. At the beginning of the injection the pulse was 140; respiration 58. At 12:15 the pulse was 80; respiration had almost ceased, having fallen to two per minute.

Artificial respiration and 1/60 grain strychnin were administered. During this time the cornea was anesthetic and the intern, Dr. Robert Reed, who made the observation, said that all the extremities were paralyzed. After a few minutes the patient improved and the breathing became normal. By 1:35 a. m. the paralysis had disappeared. At 10 a. m. temperature was 103, pulse 144, respiration 60. At 3 p. m. the child died.

The records show three other deaths at the Cincinnati Hospital during the past year, immediately following the injection of the serum, all occurring in young children.

December 20, 1911, a child aged 3½ years was brought to the receiving ward unconscious, with rigidity and retraction of the neck very marked, and Kernig's sign present. Temperature was 100.5, pulse 106. Pupils were equal and reacted to light, and the heart and lungs were normal. A spinal puncture was made by Dr. Charles Jones, the receiving physician, and 20 c.c. of turbid fluid under light pressure were removed. Following this, 15 c.c. of serum were very slowly injected, the pulse and respiration being unaffected during the time of injection. In from three to five minutes later the respiration suddenly ceased, the pulse remaining good. Artificial respiration was instituted, but was of no avail. The action of the heart continued for about two minutes and then gradually stopped. Chloroform anesthesia was used, but the patient was never in a state of complete anesthesia.

March 4, 1912, a boy aged 7 was admitted to the service of Dr. B. K. Rachford with the history of the onset of headache two days previously. He was delirious on admission with intense headache, retraction of the head, neck rigid and marked Kernig's sign. Lumbar puncture with chloroform anesthesia yielded 45 c.c. of clear fluid under pressure. Forty c.c. of serum were then injected. Five minutes after the injection, respiration became feeble and suddenly stopped. Artificial respiration was instituted, without avail. Autopsy showed the meninges intensely congested; there was no pus or fibrin, but a large amount of clear fluid was present in the cistern at the base of the brain.

Fig. 3.—Tracing obtained by injecting 2 c.c. of antimeningitis serum into the left vertebral artery of a dog weighing 8 kg. (17½ pounds). In all experiments the blood-pressure was taken from the femoral artery by manometer. The respiration was recorded by means of a Paul Bert pneumograph, the upstroke represents inspiration.

Fig. 4.—Tracing obtained by injecting 2 c.c. of 0.5 per cent. trichlorol solution into the left vertebral artery of a dog weighing 8 kg. (17½ pounds).

Nov. 2, 1912, a well-nourished boy aged 5 was admitted to the service of Dr. Rachford, with severe headache, rigidity of the neck, and a marked Kernig's sign. Lumbar puncture yielded 25 c.c. of turbid fluid. Thirty-seven c.c. of serum were injected; the child became dyspneic, but soon improved. The next day at 6:30 p. m. the child was given another 30 c.c. of the serum with good results. The following day, November 4, at 7:30 p. m., 30 c.c. of turbid fluid were again withdrawn and 30 c.c. of serum injected. Immediately following the completion of the injection, respiration ceased and the child died.

March 19, 1913, Dr. L. W. Stacey saw a girl aged 10, who had been found by her mother unconscious in bed at 8 o'clock that morning, although apparently well on the preceding day. Marked rigidity of the neck and a positive Kernig's sign were present. The child had had two convulsions that morning. Temperature was 101; respiration normal. At 12:30 p. m. 40 c.c. of turbid fluid were removed by lumbar puncture and 40 c.c. of serum were slowly injected. The injection consumed twenty-five minutes and was completed at 1:30 p. m. No anesthetic was used. The child felt the insertion of the needle. At 2 o'clock Dr. Stacey was called; the respiration had ceased, but the heart was still beating. Artificial respiration was continued for one hour when the heart ceased to beat.

March 10, 1913, a girl aged 9, whose illness began that morning at 9 o'clock with headache, rigidity of the neck and the

Fig. 2.—Diagram of lower end of spinal cord and membranes in young children; A, pia mater; B, central canal of spinal cord; C, passage leading from central canal to subdural space in region of conus; D, dura mater.

Kernig sign, was admitted to the service of Dr. John E. Greiwe at the Cincinnati Hospital. Temperature was 102, pulse 130, respiration 18. The child was unconscious on admission. At 12:50 in the afternoon 50 c.c. of turbid fluid containing Gram-negative diplococci of the gonococcus type were removed and 40 c.c. of antimeningitis serum slowly injected. The injection was completed by 3:50 p. m. At 4:05, fifteen minutes later, the child had respiratory failure; the heart sounds were regular—160, dropping to 120. Artificial respiration and camphor stimulation were maintained for four hours, but were of no avail.

We have here six deaths coming on with respiratory paralysis a few minutes after the injection, and two cases in which the respiratory paralysis was relieved by artificial respiration, the children dying later of the disease.

Because of their great similarity to those cases of respiratory paralysis following the lumbar injection of cocain, I believe them to be toxic.

In a previous article¹ I offered an explanation for the cocain cases as being due to an open central canal of the cord leading directly to the fourth ventricle. It was shown in that article that methylene-blue injected into dogs *intra vitam* into the subdural space might find its way through the central canal to the ventricular

The central canal is continued at the lower extremity into the filum terminale.

Sixty years ago Stilling asserted that the central canal opened into the posterior median fissure of the cord in the region of the conus medullaris, and during life it was probably filled with cerebrospinal fluid. This statement has been neglected or denied by most anatomists. Independently of this statement I have been able to demonstrate the opening by a new method in three spinal cords obtained from new-born children.

If a soluble anilin dye is injected into the substance of such a cord, in the lower dorsal region, for instance, and if by chance the central canal is struck, the dye will run down the central canal inside the cord, and will appear on the outside of the cord in the region of the conus medullaris and filum terminale.

If now that piece of cord which shows the dye on the outside is removed, and serial sections are made, the dye will be found staining the central canal and a passage leading from the central canal to the posterior median fissure and the outer surface of the cord.

Figure 1 is a drawing made for me by Dr. Leon Tedesche of such a section, which was prepared by Dr. E. S. May. The cord is otherwise unstained and for

Fig. 5.—Tracing obtained by injecting 2 c.c. of 0.5 per cent. tricesol solution into the subdural space of a dog weighing 7 kg. (15½ pounds) with the posterior cranial fossa open.

Fig. 6.—Tracing obtained from an experiment in which 2 c.c. of serum were injected into the lumbar subdural space of a young dog weighing 6 kg. (14¼ pounds). A few seconds after the injection respiration stopped. Artificial respiration for a half minute restored respiration which was, however, slow and irregular and five minutes later the animal died. The blood-pressure slowly sank after the injection.

system of the brain. This circulation upward toward the fourth ventricle is aided by the ciliated epithelium lining the central canal. The following is quoted from that article:

Available literature on the central canal is very limited. All authors agree that it is open in the lower animals and in young children. In the adult the results of investigation vary. Bidder, Wagner, Schroeder, van der Kolk and Stilling hold that the central canal persists in adults. Kölliker found that not infrequently the canal was obliterated in places, most frequently in the cervical region. Clarke also found the canal frequently blocked. Frommann found the canal open throughout the entire length in three out of twenty-five cords examined. In the human adult most of the evidence shows that the central canal is frequently closed at some point usually in the upper portion. In may, however, persist as a canal, and this may be the explanation for the nine per thousand deaths from cocain (stovain) lumbar anesthesia.

Attention was also called to the possible importance of the central canal in the pathogenesis of poliomyelitis.

that reason could not be satisfactorily photographed. Figure 2 is a diagram illustrating the lower end of the spinal cord and its membranes when such a passage exists. If now, in a given case the passage exists, or if a needle introduced for the purpose of making an injection should injure the filum and make an artificial opening into the central canal, a direct channel lined with ciliated epithelium would be present which might in a few minutes deliver a toxic material injected into the subdural space to the fourth ventricle.

The problem then presented itself to determine whether antimeningitis serum would paralyze the respiratory center when applied to the fourth ventricle; and further, if this was found to be the case, to determine what the offending substance in the serum might be. In a previous article² I showed that the vertebral artery delivered blood to the hindbrain directly, without going through the circle of Willis, and that we had by reason of this fact a delicate pharmacologic method for investigating the action of drugs on the medulla oblongata.

1. Kramer, S. P.: Circulation of Cerebrospinal Fluid and Its Bearing on Pathogenesis of Poliomyelitic Disease, New York Med. Jour., 1912, xcv, No. 11; abstr., THE JOURNAL A. M. A., March 30, 1912, p. 975

2. Kramer, S. P.: Jour. Exper. Med., 1912, xv, No. 4.

Figure 3 is a tracing obtained by injecting into the vertebral artery of a dog 2 c.c. of antimeningitis serum. Immediately following the injection the respiration ceased, remained in abeyance for ten seconds and then slowly recovered.

Figure 4 is a tracing obtained by injecting 2 c.c. of 0.5 per cent. solution of tricrosol in the same way with the same result.

Figure 5 is a tracing obtained from a different experiment. The posterior cranial fossa in a dog was opened, the dura was incised and the cerebellum exposed.

Two cubic centimeters of 0.5 per cent. solution of tricrosol in water were then injected into the subdural space under conditions (since the dura was opened) that prevented excess of intracranial pressure. The respiration ceased a few seconds after the beginning of the injection, the blood-pressure fell very rapidly and immediate death of the animal was prevented only by artificial respiration, which was necessary for ten minutes before the animal breathed spontaneously.

Figure 6 is a tracing obtained from an experiment in which 2 c.c. of antimeningitis serum were injected into the subdural space of a young dog. A few seconds after the injection respiration stopped. Artificial respiration for half a minute restored respiration, which was slow and irregular, and five minutes later the animal died. The blood-pressure slowly sank after the injection.

CONTROL INJECTIONS OF NORMAL BLOOD-SERUM INTO THE VERTEBRAL ARTERY OF DOGS PRODUCED NO EFFECT

In the U. S. Public Health Reports,³ Dr. W. H. Frost has described similar deaths following the injection of antimeningitis serum. In THE JOURNAL Dr. Arthur H. Parmelee⁴ has reported ten cases of respiratory failure. A letter from Dr. Parmelee states that respiratory failure in all these cases came on within fifteen minutes after the administration of serum.

Indeed, so common has this catastrophe become that in a circular issued by the New York Department of Health, directions are given as to what should be done when breathing stops following the administration of serum.

The toxicology of phenol (carbolic acid) poisoning bears out our experimental results and conclusions. It has long been known that death from phenol results by paralysis of respiration. That phenol has a great affinity for nervous tissue is shown by the fact that a considerable percentage of phenol ingested has been recovered from the brain in cases of phenol poisoning. The phenols are all readily miscible in lipid substances and this may be the explanation for their toxicity on the nervous system. For the last suggestion, I am indebted to my colleague, Dr. Julius H. Eichberg.

From what has gone before I think the conclusion is justified that serum containing 0.5 per cent. tricrosol, cannot safely be injected into the subarachnoid space.

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3. U. S. Public Health Reports, Jan. 26, 1912, p. 115.

4. Parmelee, A. H.: Epidemic Cerebrospinal Meningitis, THE JOURNAL A. M. A., March 1, 1913, p. 659.

Political Health Departments.—Certainly the very worst use which can be made of the health appropriation is to employ it for the purpose of paying political debts. Decreased efficiency is the sure result, and the community which permits such a misuse of the public funds will deservedly suffer an increasing toll of sickness and death.—Charles V. Chapin, *Am. Jour. Pub. Health*.

THE CRIMINAL PHYSIQUE

A PRELIMINARY REPORT ON THE PHYSICAL EXAMINATION OF ONE THOUSAND, FIVE HUNDRED AND TWENTY-ONE PRISONERS AT THE WISCONSIN STATE PRISON

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The only legitimate question which sociology can put to anthropology is this: "Is the criminal, and in what respects is he, a normal or an abnormal man? And if he is abnormal, whence is the abnormality derived? . . . We must study the organ before the function, and the physical before the moral.—*Enrico Ferri*."

That a definite relationship exists between physical development and efficiency is generally accepted as fact. The world-wide investigations of schoolchildren reported by such men as Dr. Porter of Harvard, the late Dr. Christopher of Chicago, Hastings in Omaha, Byer in Cambridge, Leharzig in St. Petersburg, Burgerstein in Vienna and Roberts in London all agree that at the same age the average height and weight of pupils in the higher grades is greater than of those in the lower. These exhaustive reports prove the relationship in schoolchildren between a vigorous brain and a well-developed body—that those physically most precocious are mentally most precocious. That this rule should hold equally good after adolescence is a logical conclusion although there are few data to be had on the subject. This correlation of body and mind can, no doubt, be demonstrated in any class of individuals by a collective study of the particular class.

The mental and moral shortcomings of the criminal classes are accepted as facts without the necessity of presentation of data. That as a class they are physically defective is the belief, founded on general observation, of those who are thrown into intimate relationship with them. It was the desire for further scientific and accurate proof for this belief that prompted the work on this paper and the tables here given.

The anthropometric committee of the British Association for the Advancement of Science reported on the examination of 3,000 criminals and found them to be about 2 inches shorter and 17 pounds lighter than the average Englishman. Baer of Berlin, reporting on the German criminal, gives much the same results. Quetelet and Raseri find young offenders below normal height. Lombroso and others of the Italian school report a tendency among criminals to be taller and heavier than the average Italian. Few reliable data are to be found in American literature. Hamilton Wey, reporting on 529 boys at the Elmira Reformatory of an average age between 20 and 21 years, gives an average height of 65½ inches and an average weight of 133 pounds, which is below that of the college boys quoted in my tables. August Drahts, chaplain at San Quentin, reported the San Quentin prisoner's average height as 66.8 inches.

The results of my investigation of height at the Wisconsin State Prison are quite similar to those of the anthropometric committee of the British Association for the Advancement of Science, though I am able to report on only half the number. Taking the average of 221,819 Americans examined by forty-three old-line life-insurance companies, as reported in 1912 by the Actuarial Society of America, as a type of American for comparison, I find the Wisconsin convict, as shown in Table 1, to be 1.8 inches below the average American height. Taken as a whole, the 1,521 criminals reported on are,