codein sulphate $\frac{1}{4}$ grain was given and the leg was elevated. Temperature at this time was 98 F., pulse 96, respiration 24. The patient complained a great deal on that day. About 2 p. m. the pain suddenly ceased. At 4 p. m. temperature was 101, pulse 120, respiration 24. Examination of the knee showed a soft fluctuating mass to outer side of and above the patella. At 7 p. m. a ruptured aneurism having been diagnosed, he was taken to the amphitheater and prepared for operation.

Operation.—Under chloroform anesthesia, ether being substituted later, an elastic constrictor was applied in the upper part of the thigh and a longitudinal incision of about three and a half inches was made over the center of the tumor in the popliteal space, and a large cavity filled with clotted and fluid blood was exposed to view. After washing out the blood and clots the cavity was seen to be about six inches in longitudinal and four inches in transverse diameter. Its upper boundary was not so well defined as the lateral and lower ones, the blood having evidently dissected its way under the hamstring muscles on the outer side, and between them above, where the cavity ran up into a point. On the inner aspect and near the bottom, the wall of the cavity presented an area about one and a half inches in diameter and two and one-half inches in length, which was whiter and more smooth and glistening than the rest of its surface, which was of a dark and bloody hue. This proved to be the original aneurismal sac, there being one opening in it near its upper margin and one near its lower, and about one and a half inches apart. These openings were closed with Lembert sutures of small silk on a curved needle, and, as an additional safeguard, a suture was passed completely encircling the upper opening and tied. On the removal of the elastic constrictor there was no bleeding whatever. The cavity was once more flushed with hot saline solution and packed with gauze and a large dressing applied. The limb was wrapped in cotton batting and a posterior splint of pasteboard applied to immobilize the knee. Hot cans were applied around the limb for two days. The toes were felt to be warm, however, on his return to the ward from the operating room, and the wound healed from the bottom by granulation. He made an uneventful recovery, being discharged from the hospital cured on Jan. 9, 1905.

REMARKS.

In the first case, the diagnosis of aneurism was not made till the sac had been opened, though, fortunately, the common femoral artery had been tied temporarily as a preliminary measure. In the second case, my attention was called to the patient by the appearance of a soft swelling to the outer side of, and somewhat above, the patella in a case previously diagnosed as popliteal aneurism. In both cases, hemostasis was secured by suturing the arterial openings within the aneurismal sac. The sac was not excised nor was it obliterated. The dissection of the tissues by the extravasated blood had created a cavity of such size in each case that it was deemed proper (in view of possible infection of so large a space, which would soon fill with fluid secretion from its extensive surface if not drained), to irrigate thoroughly and to use a long gauze drain; which performed its functions well, as the copious secretion on the dressing later showed. There was little or no interference with the warmth, sensation, or nutrition of the limb beyond the aneurism as a result of the operation. The functional result was perfect on discharge, the healing being complete.

The operation as described by Dr. Matas is probably the simplest and easiest operation devised for the purpose, when temporary hemostasis can be secured by an elastic constrictor, a provisional ligature, or even digital pressure. Any one who has performed the tedious, prolonged operation of ligation above and below and excision of the sac is certain to become a convert to this method the first time he tries it.

The incision required is smaller, the openings in the vessel are easily and very plainly exposed to view, and very easily closed by suture. The number of rows of sutures may be increased at the option of the operator to any number he may deem necessary to insure safety against secondary hemorrhage. The integrity of the sac is not interfered with, and as there is no dissection either around, or above, or below the sac, there can be no interference with collateral circulation so essential to the life of the limb beyond.

There is one point that is brought out by these cases and which makes them especially worthy of record, and that is, that where the aneurism has ruptured some time previously and has given rise to a cavity of such size that its obliteration by suture would become either impracticable owing to its extent, or inadvisable owing to the possibility of interference with collateral circulation by the incision and dissection rendered necessary to expose the whole cavity for the purpose of suturing, it is better to close the incision partly, and to drain, allowing the wound to fill by granulation from the bottom, instead of obliterating the cavity by suture, as is done in the unruptured cases. This can be very materially aided by gentle compression of the sac in the application of the dressing and the use of a gauze drain that will act as a wick rather than as a pack.

In Case 1, for instance, in order to have sutured together the walls of this cavity, it would have been necessary to make an incision of about fourteen inches in length. There is the additional advantage, too, of a saving of time by this method, which is of momentous importance to a large class of patients who stand operation and anesthesia badly.

THE EFFECTS OF THE INHALATION OF THE FUMES OF NITRIC ACID.

WITH REPORT OF CASES.*

J. N. HALL, M.D., AND C. E. COOPER, M.D.

DENVER.

The Denver Fire Department was called to the office of the *Denver Post* Sept. 20, 1904, at 4 p. m. On arrival they were informed that a carboy of nitric acid had been accidentally broken in an attempt to remove the stopper with a hammer. The acid spread across the floor, coming in contact with the zinc used in etching. Sawdust was used to absorb it, and, rapidly oxidizing, burst into flame here and there, resulting in the call for the firemen. Mr. Bradt, foreman of the department, who was at work in the room, states that the fumes and smoke were not especially irritating until the portable apparatus began playing on the fire, the usual carbonic acid-producing solutions being employed.

We find by examination that the acid used contained no appreciable amount of nitrous acid and was of about 38 per cent. strength. About ten gallons of it escaped from the carboy. We believe the symptoms to have been caused by the smoke, made much more irritating and corrosive by the presence of the nitric acid and the products of its union with organic matter. Dr. E. C. Hill states that under these circumstances HNO_2 would arise from decomposition of the HNO_3 , and also nitric peroxid (NO_2), and nitric oxid (NO).

Haines and Peterson¹ state that nitric oxid (NO) is

* Read in the Section on Practice of Medicine of the American Medical Association, at the Fifty-sixth Annual Session, July, 1905.
1. Text-book of Legal Medicine and Toxicology.

obtained by the deoxidation of nitric acid, by the action of this acid on metals, vegetable fibers, etc. They mention, as symptoms of acute poisoning, dyspnea, tightness of the chest, coughing, fainting, cyanosis, diarrhea and collapse. Concerning one case they state:

Blood drawn on venesection tarry, thick, black and rapidly coagulating. It is of diminished alkalinity, and on dilution becomes red and shows the oxyhemoglobin spectrum.

All of these compounds are irritating when inhaled. In view, however, of the irritant qualities of many gases inhaled in fires, in the use of disinfectants and otherwise, and the more or less similar results in most such cases, we would insist on the point that the irritation of the inhaled fumes, and not the direct chemical action, is probably the dangerous feature. Thus Dr. Hall has reported² a rapidly fatal case of bronchopneumonia resulting from the inhalation of smoke from burning weeds and grass, the subject being a feeble asthmatic of 61 years. In the same paper were reported cases from the inhalation of chlorin, of sulphurous acid, and of formaldehyd, differing only in degree from the cases we are now studying, and from each other. The chemical effect is apparently subsidiary to the irritant one in all; but, in general, we must conclude that smoke, which is not much feared by firemen, is vastly more irritating and, therefore, dangerous when contaminated with fumes of various chemicals.

Eighteen firemen and two men employed in the office were affected severely enough to demand medical aid. Of these, four died, two on the second day, from the direct consequences, and two several weeks later from relapse. The immediate symptoms complained of while exposed to the fumes were, in order of frequency, as follows: Dyspnea, pain in the stomach, pain in the chest, headache, dryness of the throat, coughing, vomiting, dizziness, difficulty in walking, and dryness of the nose. No unconsciousness was noted. Nearly all the firemen returned to their respective firehouses, not considering themselves seriously sick. After a few hours many of them sought medical aid, and within twenty-four hours all of them excepting one were patients in the Emergency Hospital.

We next present a list of the prominent symptoms noted in 15 of the 16 cases which recovered: Dyspnea, present in 100 per cent.; cough, present in 93 per cent.; pain, present in 87 per cent., especially in the sides of the chest, stomach, lungs, throat, loins and head; dizziness and nausea, present in 73 per cent.; cough of especial violence, present in 67 per cent.; vomiting, present in 53 per cent.

During the first week of illness dyspnea persisted in 100 per cent. of the cases; 93 per cent. were confined to bed during this time. Pain persisted in all those who complained of it during the first day, and in practically the same localities.

Marked prostration was present in 87 per cent. Fever in 80 per cent., generally of moderate severity. The cough generally persisted, with bloody expectoration, in 27 per cent., and voluminous expectoration in 60 per cent. The taste of nitric acid in the expectoration was complained of by several patients.

Within the first half of the second week many of them were discharged, the average time in bed for the whole number being eleven days. Ninety-three per cent. complained of general weakness, and but one felt well on arising.

Relapse occurred in 33 per cent. of these cases, generally in the third week, and averaging 15½ days in duration. The symptoms were those of the original attack, but of less intensity.

The length of time from the exposure until practical recovery in eight cases averaged 113 days, the maximum being 210 days, the minimum 90 days. Five state that they are not well yet, and two failed to answer.

Those having any remaining symptoms nine months after the attack number eleven, or 74 per cent. These symptoms, in order of frequency, are dyspnea, "nervousness," stomach troubles of various kinds, cough, dryness of throat and nose, pain in the chest, loss of weight, dyspnea on inhalation of smoke, dizziness, pain in the loins, and headache.

There was a loss of weight in 87 per cent. of the men, entirely regained in 40 per cent., not regained in 13 per cent., and no reply was made in 47 per cent. The average loss was 25 pounds, maximum 40 pounds, minimum 20 pounds. The average regained was 18½ pounds, maximum 30 pounds, minimum 5 pounds.

Sixty per cent. find they are more susceptible to cold now than previously. The dryness of the nose is thought to be due to a beginning chronic rhinitis, due to the irritation of the fumes inhaled. The dyspnea on inhalation of smoke may well be largely nervous in origin, but doubtless in part because of the increased susceptibility of the bronchial mucous membrane due to the action of irritants. The pains in the sides of the chest are, we believe, pleuritic in origin. They were exceedingly severe in some of the cases in the first days of the illness, indicating at that time a dry pleurisy, since friction sounds were heard. The later pains may well have been sequential to such a pleurisy. The rapidity with which the pain developed in some cases suggests the likelihood of its having arisen from direct irritation of the lung by the acrid smoke.

Albumin was noted in at least one of the cases, but evidently no such damage was done to the kidneys as in some cases we have seen in which acute nephritis followed the swallowing of mineral acids. Probably little of the acid was absorbed, most of the damage from it being caused by its irritant effect.

Two of the cases died on the second day, one on the twenty-second day during a relapse, and one at the end of one month, also during a relapse.

The two who died on the second day were affected about as were those who recovered, but more severely. Cough was not a notable symptom. Cyanosis, nausea, diaphragmatic pain, dyspnea and vomiting were noted early. In both there was unconsciousness for several hours before death, and the physical signs of a progressive bronchopneumonia, but without the fever and other constitutional symptoms of an infectious disease. One of these had an extremely rapid pulse. Both expectorated frothy, blood-tinged serous fluid for some hours before death. Dr. P. V. Carlin informs us that pneumothorax developed in one of them.

The two who died during relapse suffered about as the others did during the primary attacks. Both were comparatively well during the interval. Both were exposed to cold and almost immediately entered the relapse. The two cases were similar enough so that the following description may well answer for both:

The sputum was blood streaked, thin and abundant. The cough was at times violent. Pleuritic pain was severe (and in one severe pain existed in the pharynx, larynx and esophagus). Large and small râles were

2. Phila. Med. Journal, 1902. "Bronchitis and Bronchopneumonia from Inhalation of Irritants."

abundant, at first in the lower portion of the chest, and gradually extending upward. There was moderate rise in temperature, pulse and respiration. The cyanosis was intense (and not relieved by oxygen in one of the cases, although somewhat so in the other). Both died with all of the symptoms and signs of a desperate bronchopneumonia.

Before the relapse both of the men had been discharged from the hospital as recovered from the acute condition, although both complained of moderate exhaustion, such as is common to the period of convalescence from any acute illness.

In one of them examined the day before the relapse, no physical signs of disease were found. We believe that exposure to cold, which occurred in both cases, was the exciting cause of a renewed and virulent inflammation, rapidly extending into a definite bronchopneumonia, as above described.

On two patients autopsies were held, unfortunately unknown to either of us. We quote portions of the reports to the coroner by Dr. W. S. Holmquist and Dr. H. R. McGraw:

Dolloff.—"The pericardium showed spots of metallic luster on the upper surface. The heart was filled with extremely dark coagulated blood, less consistent than clotted blood. Pleuræ free. Lungs large and voluminous, on section bled freely. Some spots were devoid of air. Bronchioles filled with bloody fluid. Much of the lung tissue was edematous and heavy. Mucosa of bronchi perceptibly thickened."

Diagnosis.—Deceased died from asphyxia, due to an acute congestion of the lungs; and a pathologic change in the hemoglobin of the blood."

Eyman.—(Died in relapse, one month from exposure.) The essential features are stated by Dr. H. R. McGraw "to have been those of a bronchopneumonia, with almost complete solidification of lung in places. Sections from these solidified portions showed superficial coagulation necrosis and the alveoli were found filled with necrosed cells in places. Other parts showed a beginning fibrous development. Deposits of blood pigment were noted in spots upon the peritoneum. Dilatation and hypertrophy of the heart. No changes were noted in other organs."

The pathology, in our opinion, is a combination of purely local and general effects. Locally, the inhalation of the nitrous and nitric oxides, the products of combustion, and of the chemical reactions between the acid, zinc, and the chemical solution used to extinguish the blaze, assisted by the violent respiratory efforts occasioned by the physical exertion, produced an irritation and probably a mild coagulation necrosis of the mucous membrane of the air passages and the alveoli. In the two cases that died early there was produced promptly a severe bronchopneumonia. In those dying during a relapse the necrotic areas were largely cleared up by absorption and exfoliation, leaving exposed a delicate and susceptible membrane. The exposure to cold was sufficient to excite a bronchopneumonia of especial intensity on this account, proving rapidly fatal. Dr. Hall has reported³ a case of lobar pneumonia in which, twenty-three days after recovery, a robust young man was exposed for a few hours to severe cold (about 20 degrees below zero), and died in a few hours of acute pulmonary congestion. It is probable that the fatal result in this case, as in those we are studying, was due to a bronchopneumonia, with great accompanying edema.

The cyanosis in the severe cases was extreme. It was doubtless in part purely mechanical, as in ordinary bronchopneumonia, but largely due to the changes pro-

duced in the hemoglobin to which we have referred, and which interfered with its oxygen-carrying capacity. We await anxiously the careful investigations of Drs. Holmquist and Edson on this feature of the cases which they have studied.

The treatment generally followed, we believe, was that of an ordinary severe bronchopneumonia. Oxygen was used in all of the severe cases, with differing but generally unsatisfactory results. In a severe case of Dr. Cooper's, aconite in minim dosage, with vigorous external counter-irritation, was followed by marked relief. This was the patient who finally died in the relapse on the twenty-second day, these measures proving ineffectual at this time.

To us it seems that the one most important factor in determining the question of death or recovery was the severity of the initial exposure. Theoretically, the inhalation of ammonia at the time of exposure should be of benefit, but this would hardly be practicable. We believe that, at present, stimulation, the use of oxygen when indicated, atropia for the edematous exudation, vigorous counter-irritation, with eliminative and supportive measures offer us the most hope in the primary attack. If recovery occurs, we would strongly urge suspension from work, rigorous avoidance of exposure, and residence for some months in a warm, equable climate, such as one would choose for a feeble patient with chronic bronchitis. Those of the Denver cases who were able to follow such a course are at present working, and without serious symptoms. In view of the lessened pulmonary resistance, we would suggest also the adoption of effective measures for the avoidance of infection by the bacillus of tuberculosis.

If we can not save all of those exposed in the performance of their perilous duties to the inhalation of dangerous gases, we should insist the more strongly on the avoidance of anything tending to bring about relapse, which we have noted to be so fatal.⁴ It is likely that we can save more lives by strict attention to this feature than by any other single measure.

We are under especial obligations to Dr. W. H. Sharpley, Health Commissioner of the City and County of Denver, for his encouragement and assistance in the preparation of this paper; to the Denver Fire Department, and to the physicians who attended other cases than those which we saw, who have so generously given us their aid.

DISCUSSION.

DR. N. H. NEILSON, Milwaukee, Wis., reported having the same experience in Milwaukee, two years ago, showing the effects of the fumes of nitric acid by inhalation. The men who were engaged in putting out the fire returned to the station house, and within one or two hours—six or seven hours after the exposure—they began to have symptoms of pulmonary congestion, as described in the paper. Some of the men died and some recovered for a time, but had relapses. Some had a chronic bronchitis and were sent to Texas, where they recovered—all but one, who became despondent and committed suicide. In these cases it was believed that the pulmonary edema was the result of the local irritation on the mucosa and not a systemic effect. Whatever systemic effect there was was from the inflammation alone. Dr. Neilson did not think that a report of the cases was published.

DR. JOHN H. MUSSER, Philadelphia, said that the autopsy findings in such cases do not support the belief in the presence

4. In the case of a fireman, quoted by Dr. Hall in the above-mentioned article as dying from inhalation of smoke containing fumes of some undetermined acid, the death was also during relapse, being directly caused by pulmonary embolism from a phlebitis of the leg, at the end of the fifth week.

3. Denver Medical Times, 1898.

of any pleuritis, and he, therefore, asked as to the occurrence of the inflammation and the vomiting.

Dr. G. W. McCaskey, Fort Wayne, Ind., thought that the symptoms in these cases indicate a degree of exhaustion unusual with a simple irritative bronchitis, and that the evidence points toward a severe toxemia as a result of absorption of the poisonous gases. It is peculiarly the function of the respiratory tract to absorb gases, and it seems only reasonable to suppose that such absorption would take place and should be considered in accounting for the very severe constitutional symptoms manifested by these cases.

Dr. J. N. Hall, Denver, remarked that it was rather difficult to report these cases with any degree of accuracy, because they fell into the hands of about twenty physicians. Dr. Cooper took care of six and Dr. Hall three. A pleuritic friction was well marked, beginning within twenty-four hours. Necropsies were made by the coroner's physician, and the bodies were buried before Dr. Hall knew of the deaths. He, therefore, had no opportunity to study the pathology. The toxemia was similar to what would be expected from inhalation of chlorin, formaldehyd or smoke from burning grass, but no case pointed definitely to a toxemia from the acid itself. Dr. Hall could not explain the vomiting. Although none of those exposed were supposed to be sick enough to keep in, at the end of twenty-four hours they came back to the hospital.

Special Article

IMMUNITY.

CHAPTER XXI.

BOTULISM.

Botulism is a peculiar form of meat poisoning in which the nervous system is involved principally. From twenty-four to thirty-six hours after meals, salivation, ptosis, dilatation of the pupils and paralysis of the ocular muscles develop and death from bulbar paralysis occurs rapidly in from 25 to 30 per cent. of the cases. In the event of recovery, convalescence may extend over weeks or months. In 1895 V. Ermengem investigated a ham which had caused 50 cases of botulism, and isolated from it an anaërobic, spore forming bacillus, which produces a soluble toxin capable of causing the entire symptom-complex of the disease.¹

The organism possesses flagellæ, has limited motility, grows only in alkaline media, and in contrast to most pathogenic organisms prefers a relatively low temperature (18-25° C.). It is probably on account of its physiologic activity at such temperatures that it is able to produce its toxin in meats which have been kept in a cool place. It is found in decomposed ham and various sausages (Leberwurst and Blutwurst.) The Germans speak of the disease as Wurstinfection. The disease occurs especially in some European districts in which improperly preserved or raw meats are eaten. The bacillus appears to gain access to the meat after the animal has been killed. V. Ermengem investigated two hams from the same animal. One was under anaërobic conditions being covered with brine while the other was exposed to the air; only the former was toxic. The organisms may be absent from the superficial portion of the meat, but abundant in the deep portion. Aside from its occurrence in meat nothing is known of the life history of the bacillus. The term ichthyosismus is applied to a similar or identical disease which is caused in Russia by salted fish.

The disease is caused by the toxin which has already been produced in the meat and not to the activity of the organisms after it has reached the alimentary tract (v. Ermengem). If an extract of the meat is made with water and the bacteria removed from the latter by filtration, the fluid shows characteristic

toxicity for animals. This may be used for determining the presence of botulism toxin in suspected meat. The guinea-pig is the most susceptible animal. The spores of the bacillus are relatively susceptible to heat, being destroyed by a temperature of 80° C. for one hour.

According to v. Ermengem, the bacillus does not proliferate in the body, nor does it produce toxin vigorously at body temperature, hence he considers it to be a strict saprophyte—a pathogenic saprophyte.

The toxin is taken up by the circulation from the alimentary tract and is not destroyed by the gastric and pancreatic juices, differing in this respect from the toxins of diphtheria and tetanus. It is prepared artificially by growing the organism anaërobically in suitable bouillon and subsequently sterilizing the fluid by filtration. Like the other soluble bacterial toxins, it is susceptible to the action of air and light, and is destroyed by a temperature of from 60 to 70° C.

That the toxin has a special affinity for the nervous tissues is evident from the symptoms of the disease. An emulsion of nervous tissue when mixed with the toxin absorbs or neutralizes it and the ganglionic cells are found to be degenerated in fatal cases of infection. The toxin, however, appears not to be so selective in its action on the nervous tissue as the toxin of tetanus, for in botulism degenerations of the glandular organs, and of the vascular endothelium with consequent hemorrhages are characteristic anatomic findings. On the basis of clinical evidence man is very susceptible to the intoxication. Dogs, rats, and cats are relatively immune. The toxin is pathogenic by subcutaneous or intravascular injection.

According to v. Ermengem, the bacilli when inoculated subcutaneously do not proliferate, but are taken up by the phagocytes immediately or after they have been carried to other organs. Animals which have recovered from infection or which have been immunized, acquire rather strong immunity to subsequent inoculations, the immunity being antitoxic.

The prophylactic measures consist in the avoidance of poorly preserved and improperly cooked meats, especially sausages. Botulism would seem to be very rare in this country where raw meats are not used extensively.

The antitoxin (Kempner) has proved of some value in animal experiments but its commercial preparation has not been warranted on account of the rarity of the disease.

BACILLUS PYOCYANEUS.

For a long time it was thought that the "bacillus of blue pus" was of no importance as an infectious agent for man although its pathogenicity for animals had been recognized experimentally. It is found with some frequency in the blood and organs of man at autopsy, when death has resulted from some other infection or chronic disease; in such instances it is supposed that a so-called "agonal invasion" by the organism has occurred. During recent years, however, several cases of primary pyocyanus septicemia have been observed, the bacillus having been obtained from the blood in pure cultures during life or from the blood and organs shortly after death. It has been found as the sole organism in meningitis and vegetative endocarditis. Some of the cases indicate, however, that a previous lowering of resistance, as in tuberculosis and syphilis, is important for general invasion by the bacillus. It has been found several times in suppurative processes in the middle ear, and would seem to be either the cause or a strong adjuvant in some cases of severe enteritis, especially in children. In systemic infections, the symptoms are typhoidal in character with high temperature, diarrhea and a tendency to the formation of hemorrhages in the skin and internal organs.

The *Bacillus pyocyanus* is widely distributed and that it causes so few infections is probably due to its low pathogenic power. It is an organism of manifold activities. It produces a substance which when exposed to the air, assumes a bluish tint, on which the color of the pus depends. This substance, pyocyanin, is soluble in chloroform from which it

Its Manifest Activities. It produces a substance which when exposed to the air, assumes a bluish tint, on which the color of the pus depends. This substance, pyocyanin, is soluble in chloroform from which it

1. Other pathogenic organisms, especially *B. enteritidis* and *B. coli communis*, and recently the paratyphoid bacillus, have been found in poisonous meats. The term botulism formerly was applied to various forms of meat poisoning.