in the lower animals and in man for every cortical region of the special senses. For practical purposes of diagnosis, however, the only one that claims attention in the human being is the musculocutaneous or main motor region. The human being has an auditory motor region, a visuo-motor region, etc. As shown by the investigations of Flechsig and the experiments of Grünbaum and Sherrington, Schäfer and others, motor centers are situated along the calcarine and parieto-occipital fissures and the posterior extremity of the intraparietal fissure. These centers may be largely in abeyance in the human being, their place having been taken as the result of racial and individual evolution by the more frequently employed oculomotor centers of the main motor area. Dr. Weisenburg, he said, has not laid particular stress on what appears to be a matter of much clinical importance, namely, the difference between the results caused by a lesion of the oculomotor cortical center of one side, and lesions occurring simultaneously or successively in these centers on both sides of the brain. The oculomotor centers of one side are probably effective in the control of movements of both sides. Therefore, lesions of one side may fail to give persisting symptoms. Dr. Mills said that the view advocated by Dr. Weisenburg is probably correct, namely, that the nuclei of the nerves supplying the internal recti and those supplying the external recti of both sides are connected by special tracts.

DR. W. G. SPILLER, Philadelphia, considers that perhaps one of the most important conclusions stated by Dr. Weisenburg in his report of the sixteen cases with necropsy, is that conjugate deviation of the head and eyes can not be used as a clinical sign of lesions of any particular part of the brain. Dr. Weisenburg's views resemble those entertained by certain neurologists in regard to word-seeing. By some it is held that the center for word-seeing is in the angular gyrus of the left side; by others that the loss of word-seeing produced by a lesion in this gyrus is caused by a destruction of the fibers passing beneath this gyrus to the first temporal convolution. The latter resembles the view advanced by Dr. Weisenburg, viz., that there is no definite center in the angular gyrus for conjugate movement of the head, and that when deviation occurs from a lesion here, it is the result of destruction of the fibers beneath the cortex. Numerous observations are needed to establish this view. Dr. Spiller agrees with Dr. Weisenburg that there are probably separate centers for the movements of the head and eyes. In some cases there is deviation of the head without conjugate deviation of the eyes, while in other cases the two may exist together, and not infrequently one will disappear without the other. Dr. Weisenburg's idea that there may be a latent deviation in every case of apoplexy with hemiplegia, shown by the inability of the patient to look toward the paralyzed side, is interesting, Dr. Spiller said, but difficult to prove, as usually consciousness is lost and it is impossible to obtain voluntary movement of the eyes. Cases occur, however, in which this examination may be made.

Dr. Spiller cautioned against the improper estimation of incoördinate movements of the eyeballs present shortly before death. Such movements at that time have little diagnostic value. In his paper, read before the American Neurological Association, in 1905, on "Paralysis of Associated Ocular Movements," he made no reference to congenital cases, or to experimental work on animals, but referred only to the condition as acquired by man. In that paper he expressed the view that persistent paralysis of associated upward movement of the eyeballs is due to a lesion near the oculomotor center. If there could be a lesion in each cortical center for the movements of the eyes, they might together produce associated upward paralysis, but lesions are not likely to occur exactly symmetrically on the two sides of the brain. Von Monakow, he believes, reports a case in which there was a lesion between the oculomotor centers beneath the floor of the aqueduct of Sylvius; there was no loss of individual movement of the eyeballs, but there were no associated movements because of the destruction of the connecting fibers. Since the presentation of his paper in 1905, Dr. Spiller has had the opportunity of observing two more

cases of paralysis of associated upward movement of the eyeballs. One of these patients was under the care of Dr. Potts, and the condition seemed to be caused by a lesion in the optic thalamus, as in connection with other symptoms, sensory hemiplegia persisted and motor hemiplegia largely disappeared. The other case was that of a patient of Dr. Langdon, in the service of Dr. George E. de Schweinitz, seen by Dr. Spiller in consultation. A young man, aged 17, who had been perfectly healthy until March, 1906, began to have disturbance of vision, and had to leave work; he complained of stiffness in his limbs and joints. When seen on May 12, 1906, he was found to have complete paralysis of upward movement of the eyeballs, choked disc on the right side, loss of the patellar tendon reflex and of the Achilles tendon reflex, and hemianopsia, but no paralysis of the limbs. He entirely recovered. It was probably a case of polioencephalitis superior, for which no cause could be found.

In one of his cases reported in his paper, of complete paralysis of upward associated movement of the eyeballs, death occurred in May, 1906. Dr. Spiller was so fortunate as to obtain the patient's brain through Dr. Cadbury. Shortly before going to Boston Dr. Spiller examined a number of sections from this case. There was nothing abnormal that could be seen by the naked eye. It was only by staining section after section and examining each very carefully that he was able to discover a very minute tumor of the cerebral peduncle near the oculomotor center. Dr. Spiller still believes that when there is persistent paralysis of upward associated movements of the eyeballs it is due to a lesion near the oculomotor nuclei.

DR. T. H. WEISENBURG, Philadelphia, said that in his paper reference to the cases in which lesions involve the oculomotor centers of either side was only brief, as these cases are very rare, and besides a critical study has shown that in not one were the lesions limited to the oculomotor centers. Regarding Dr. Mills' opinion that there is a distinct motorocular center in the occipital lobe, Dr. Weisenburg said he is not fully in accord because of the lack of such evidence. He has no reason, however, not to think so for if Dr. Mills holds any view it is only a question of time when it will be proved to be true.

ARSENIURETED HYDROGEN POISONING.

WITH REPORT OF FIVE CASES.

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Our knowledge of the toxic effect of arseniureted hydrogen gas, ASH_3 , on the animal body is limited yet to the experimental results of certain investigators of the origin of icterus, notably of Stadelmann, Minkowsky and Naunyn and Eppinger and to the scattered clinical reports of less than one hundred cases of poisoning in man. It was believed at the time of the occurrence of these five cases here detailed that numerous others would be reported from the different mining districts which had made use of the MacArthur-Forest cyanid process in the working of low grade gold ores, owing to the numerous attempts to smelt locally the zinc "product," which contains the gold values. But after the lapse of eight years these cases remain the only instances of such poisoning from this source that have come to my attention. Hunting through the meager literature of the subject, I have been able to collect the reports of fifty-five cases. They are all isolated in nature; some of them in the persons of experimental chemists, others in laborers in anilin dye works, several among makers of toy balloons. Only in one instance, reported by Trost in 1873, was this form of arsenic poisoning the result of a metallurgical process. Here it concerned the technical recovery of silver from lead

ore, in the course of which procedure zinc was added to the ore charge, smelted, and a zinc-silver product obtained, which, in turn, was treated with a warm dilute hydrochloric acid solution to render the zinc soluble and the silver insoluble as their respective chlorids. Both the zinc and the hydrochloric acid contained arsenic as an impurity, the latter 0.027 per cent., and as a result nine workers became poisoned with the generated arseniureted hydrogen gas, three of them fatally.

This compound of arsenic has been known since 1775, when Scheele discovered it while experimenting with arsenic acid. Its intense toxic properties were not known until Gehlin, a Munich chemist, fell victim to it in 1815. Producing the gas intentionally from known arsenic salts, he attempted to recognize its presence by the odor and inhaled enough to cause his death nine days later. The briefly reported symptomatology of this, the first case, corresponds closely with all others observed. Since this time it has been closely studied chemically, and its production is known to occur under the following conditions: (a) By the action of nascent hydrogen on a soluble salt of arsenic; (b) by the action of dilute HCl or H_2SO_4 on the arsenids of zinc or tin; (c) by the action of water on the arsenids of alkali metals, and (d) by the action of a hot solution of potash and powdered zinc on reducible compounds of arsenic. It is a colorless gas with a strong odor of garlic; soluble in 5 volumes of water, of neutral reaction, and possessing a density of about three times that of air. It oxidizes slowly in the presence of air and moisture with deposition of the element. It burns with a greenish, almost colorless flame, with formation of arsenous oxid, As_2O_3 . Its mixtures with air or oxygen are explosive. Just why arseniureted hydrogen is the most poisonous of all the mineral compounds of arsenic is not definitely known. It contains a relatively high percentage of arsenic. It is a diffusible gas and capable of rapid absorption from the lung tissue. But it is possible that its great toxicity is due, in part at least, to certain properties acquired from its combination with hydrogen.

The salient points in the clinical histories of the published cases are best reviewed in tabular form, more detailed individual description being unnecessary, as all cases showed much the same symptomatology, and many of them have been reviewed by other writers, namely, by Geigy and Becker.

For the following brief clinical reports of these five cases I am indebted to Dr. A. L. Castleman, then of Mercur, Camp Floyd Mining District, Utah, and to Dr. A. J. Hosmer, of Salt Lake City, under whose care the patients were:

CASE 1.—1896. D. C. J., metallurgist; a young, well built, healthy man.

History.—About two hours after having worked with the refining of zinc product from an experimental cyanid mill, he was suddenly seized with a feeling of intense malaise and chilliness, soon followed by intense abdominal pain which radiated toward the back. The first urine voided was dark and bloody; urination became more frequent and a larger quantity than normal in 24 hours was passed. The bloody character subsided slowly, the urine becoming clear after the sixth day. Jaundice set in early; it was of a distinct yellowish type like that of an acute catarrhal jaundice, but soon becoming of a bronze color. This disappeared slowly during convalescence. Slight fever, always under 100 F., was noted during the first three days. The pulse was rapid and easily compressible. There was no dyspnea at any time noted. The patient was not allowed active movement. The liver, spleen and kidneys were never palpable. The severely acute symp-

toms disappeared after three days. Convalescence required five weeks, but a moderate degree of anemia remained for several weeks more. At time of writing, 10 years from time of illness, the patient is entirely well, shows no signs of kidney lesions and has passed examinations for life insurance.

CASE 2.—Aug. 22, 1898. J. W., helper; aged 34; good health.

History.—The man was suddenly overcome about 5:30 p. m., while at work over a vat in the zinc cyanid refining plant of the Golden Gate Gold Mining and Milling Company, Mercur, Utah. The vat contained the zinc cyanid product, sulphuric acid and various impurities from the ore, especially large traces of arsenic. The patient was carried into the open air by the other workmen, where Dr. Castleman found him a few minutes later. He was then in a semi-dazed condition; could not stand; complained of coldness, numbness and cramping of the extremities and of severe nausea and vomiting. The vomitus was the normal stomach contents. The skin was livid in appearance, pulse 72, temperature normal. A small quantity of urine voided at this time looked normal to the eye. The patient was removed to his house. At 6:30 p. m. severe abdominal pain set in, which radiated into back and loins, and of which he complained bitterly, although he remained in a semi-stupor. Vomiting continued every 15 or 20 minutes. Diarrhea was present. At 7 p. m. the condition of the patient was the same and naturally voided urine appeared normal. Temperature was normal. The patient later became very restless, even when free from pain. At 10 p. m. hiccough set in and his skin began rapidly to assume a bronzed color. At this time he tried to pass urine but failed. There was much vesical tenesmus. Catheterization afforded one ounce of black urine containing much heavy sediment. This was the last urine obtained although frequent catheterization was resorted to. The following morning the skin was of a deeper bronze or copper color. Vomiting and hiccoughing continued at frequent intervals. The stools were dark and glairy in appearance. The vomitus was stained a green color. Pulse persisted from 110 to 120, with some irregularity and low tension. There was no delirium, but the stuporous condition remained. The patient lost strength until 10 p. m. of August 23, when he became unconscious and died the following morning, 60 hours after his exposure to the gas.

Examination of Urine.—I later examined the catheterized urine and found it to contain large quantities of methemoglobin, some bile pigment, large quantities of detritus, seemingly disintegrated red blood corpuscles, and some washed-out pale looking intact corpuscles. Small traces of arsenic were found by the Reinsch test, but not with a Marsh apparatus. The stools contained much bile pigment. Blood smears made by Dr. Hosmer showed an evident anemia due more to a solution of the hemoglobin contents than to an actual disintegration of the red cells. Blood counts were not made.

Autopsy.—Six hours after death. Body of a well developed and nourished man. Rigidity was present and some posterior lividity. Skin was uniformly copper colored, darker over face, neck and upper chest. Subcutaneous fatty tissue and muscle were copper colored. Abdominal and pleural cavities were negative except for slight brownish staining. Lungs were negative. Pericardial sac was filled with brownish fluid. Myocardium was deeply copper stained, otherwise negative. Stomach contained small amount of mucus. Scattered submucous ecchymoses appeared throughout, more marked at cardiac end of lesser curvature. The intestinal mucous membrane was uniformly injected; the descending colon was small and contracted. Liver weighed 2.600 grams; it was dark colored and the cut surface was very bloody; lobular markings were fairly distinct. The gall bladder was distended with a large amount of black, dense, tarry bile. Spleen weighed 320 grams, black; pulp soft and bloody. Malpighian bodies were visible. Kidneys together weighed 290 grams; they were dark purple colored. Capsule stripped readily. On the cut surface a large, hemorrhagic, undifferentiated appearance was seen, soft and bloody. Cortical markings were lost. The renal pelvis was empty and mucous membrane smooth. Bladder was small, empty and contracted to large walnut size. Bone marrow of ribs and right femur was stained deep copper color. Other organs were negative. Brain and cord were not examined.

Microscopic Examination.—The tissues had been hardened in 70 per cent. alcohol. Preparations were made with (a) hematoxylin and eosin; (b) alum carmin, potassium ferrocyanid and hydrochloric acid, and (c) alum carmin, equal part solution of ferrocyanid and ferrocyanid of potassium and hydrochloric acid.

Liver: The structure of cords of liver cell is well maintained, the nuclei staining well. Masses of orange, brown and black pigment granules are seen in all cells, more marked in the region of the intralobular veins and at the peripheries. The radicles of the portal vein are filled more or less with coagulum and corpuscle debris. There is an absence of round-cell infiltration. There is an absence of Prussian blue precipitation in the cyanid preparations excepting in the contents of the hepatic veins. This is stained quite uniformly bluish.

Kidneys: The outlines of the tubules and the glomeruli are fairly well retained. The capsules of the latter are filled with a lightly granular coagulum containing some few isolated well-stained cells. The convoluted tubules are thoroughly disintegrated. A heavy granular coagulum fills each lumen. The cuboidal and short columnar cells of the small collecting tubules have undergone the least destruction of any, yet they all show necrotic changes. There is an irregularly uniform, slight increase of the interstitial connective tissue. Nowhere is any marked round-cell infiltration noticed. Formed blood cells are sparingly seen. Throughout the cortex the Prussian blue reaction is seen only in scattered areas. Immediately beneath the capsule is an area 1 to 2 m.m. thick which shows an almost structureless condition. Here the cyanid reaction is well marked. In certain portions of the medulla this reaction is prominent. It seems to bear no relation to the amount or location of corpuscle debris.

Spleen: The splenic pulp is loosely arranged. The Malpighian corpuscles numerous and small. Certain large areas of necrosis are seen, composed of a reticulated coagulum, taking an eosin stain well, and containing in its meshes corpuscle debris and many pale corpuscles from which the hemoglobin contents have been removed. No extra vascular hemorrhage is seen. No evidence of the iron reaction is found in the cyanid-treated preparations.

Bone Marrow: Normal structure. Blood vessels contain more or less coagulated mass of debris in which there is considerable brownish or black pigment granules. Some of these granules give a Prussian blue reaction; most of them do not. About a few of the vessels a diffuse blue staining is seen, not associated with the granules nor extending into the lumen of the vessel.

Tissues from other organs were not received. Pieces of the kidney treated by the Reinsch test gave traces of arsenic. The liver and spleen did not do this.

Anatomic Diagnosis.—Acute hemorrhagic nephritis; acute splenic tumor with areas of necrosis; acute hepatic tumor; acute disseminated submucous hemorrhages of stomach and intestines, mild; diffuse red blood corpuscle destruction; diffuse discoloration of superficial and deep tissues.

CASE 3.—L. G., assayer, a well developed, healthy man, was exposed to generating arseniureted hydrogen gas at the same time as the patients in Cases 2, 4 and 5.

History.—Four and a half hours after exposure, while sitting in the doctor's office talking with him and feeling well, he suddenly became cold, weak, very pale and numb about the feet. He walked a short distance to his house with the help of a companion, but fell as he entered the door and could not rise. He was spized soon with nausea and considerable lumbar pain; no abdominal pain. His urine became rapidly bloody, remaining such for seven days. It was increased in amount. He began to turn yellow about the time of the beginning of his pain. This deepened in a day's time to a bronze and later took on a distinct greenish tinge. Temperature remained about 100 F. or less for three days, then went to normal. The pulse was accelerated, but of moderately good tension. Convalescence lasted six weeks, after which a decided anemia remained for some time. The patient is now living, is well and has never shown signs of kidney trouble.

CASE 4.—J. M., helper, a healthy man, suffered same exposure to gas as former two patients.

History.—He was taken sick in a similar way to patient in Case 3 while standing on the street, five hours after exposure. He was assisted home, and also fell to the ground on reaching the house and was unable to rise. He had walked probably the length of one and a half of the ordinary city blocks. The patient's symptoms were severe from the start. His urine became hemorrhagic and on the fourth day nearly ceased. After that until his death, on the ninth day, only from 5 to 10 c.c. of urine could be obtained in 24 hours by catheterization. An early jaundice passed rapidly into a brown color of the skin and scleræ. The pulse became rapid and weak, and toward the end the man became comatose and died without delirium or convulsions. No autopsy was obtained. Blood smears from this case showed the same washed-out appearance of the red cells, rather than an extensive erythrocyte destruction.

CASE 5.—A., helper, a healthy man, some time within 24 hours after exposure began to pass bloody urine and developed a jaundice like that of a mild acute catarrhal jaundice. His hemoglobinuria lasted four days, at the end of which time he returned to his work. His symptoms, consisting mostly of slight chilliness and malaise, were indefinite and unimportant in character. The patient made a complete recovery, is now living and is well.

ETIOLOGY.

Wherever the formation of arseniureted hydrogen, intentionally or unintentionally, is possible, poison cases will occasionally be met. With the extensive application of the MacArthur-Forest cyanid process in the handling of low grade gold ores, which has as its principle the solution of the gold values from the ore by means of a dilute potassium cyanid solution and the recovery of the values from this solution by its filtration through zinc dust or shavings, which precipitates the gold partly in the form of fine metallic gold and partly as a double cyanid salt of gold and zinc, it was expected that cases of arsenic poisoning from this source would be rapidly multiplied: First, because arsenic is a frequent constituent of ores and more or less of it passes into solution and is collected in the product, and, secondly, because it is often an impurity of the zinc and also of the sulphuric acid sometimes used in the refining of the product. However, no other cases have been reported from any of the mining districts in South Africa, Australia, or from this country where the cyanid process is extensively used, so that we are justified in placing these cases in the list of accidental poisonings which have occurred infrequently in the arts and in experimental laboratories.

Of the sixty cases here recorded, seventeen patients were scientific men or their students, fourteen were workers in metallurgical reduction works, seven in anilin dye works. Ten were Italian balloon peddlers who generated hydrogen gas from scraps of zinc and impure acid and made their own balloons. Barker's case is that of a man who was cleaning castings in a foundry with sulphuric acid. In the manufacture of chemicals, as zinc chlorid, these accidents have occurred, so that the possible source of this form of arsenic poisoning is wide, and one may wonder, indeed, that so few cases have been recorded.

PATHOLOGY.

The pathology of these cases differs in many ways from that of other arsenical salt poisonings. The blood and chief excretory organs receive the brunt of the effect of the gas—the blood directly, the kidneys both directly and indirectly. The skin is discolored from the deposition of pigment in it. The degree of color depends on the degree of transformation of the iron portion of this pigment. The lungs are usually nega-

Occupation.

* Small amount. † Scanty. ‡ Reference only (Index Medicus.)

tive; edema of the dependent portions has been noted. In patients who have lived some days before death has occurred a moderate degree of fatty change of the myocardium has been described, but never are there the high grade fatty changes of the parenchymatous organs that are seen in phosphorus poisoning, for instance. There is a notable absence of fatty degeneration. The kidneys are usually somewhat enlarged, dark colored, very bloody and the seat of a high grade hemorrhagic nephritis. The tubules are filled with detritic casts, the blood vessels with broken-down red blood cells. The glomeruli are least involved. Round-cell infiltration is not much seen, for the reason that the process is so intense and so little time elapses that reactive measures have not time to take place. The liver is large, dark colored and bloody; the cells contain much pigment and but little fat. The biliary radicles contain pigment. The gall bladder is distended in all reported cases with a thick, tarry bile, and the bile ducts are open. The spleen shows acute tumor, the stomach and intestines have nothing characteristic, except the large amount of bile in the contents of the latter. All serous membranes are more or less stained. Traces of arsenic have been obtained from the urine, kidney, liver, bile and blood by different investigators. Iron-containing pigment is rather generally found throughout the body as shown by cyanid preparations.

SYMPTOMATOLOGY.

Three symptoms stand out as fairly characteristic of this type of arsenic poisoning: Pain in the region of the kidneys, jaundice and hemoglobinuria. The long period between the inhalation of the poison and the onset of the symptoms is the opposite of that of other arsenical salts. Although this period varies within limits, it is seldom less than one hour and usually is several. The shortness of the period depends to a large extent, though this also varies, on the amount of arsenic inhaled. Becker's patient experienced symptoms within one-half hour and terminated fatally in three days. Still, in this case the patient had been at work in the same laboratory room the entire afternoon and could easily have been poisoned several hours before the time noted. In all cases of moderate or great severity the onset is fairly sudden with the feeling of coldness or with chills, rapidly oncoming prostration, dizziness, headache, numbness of the extremities and pain. Nausea, in some cases vomiting, is found, associated usually with the pain and, in a measure, proportionate to its severity. The vomitus is first the normal stomach contents, later it is mixed with more or less bile. In one case of Vallette's a quantity of black blood was vomited once.

The pain is usually severe, sharp and paroxysmal, though the patient is seldom entirely free from pain, and in the majority of cases it is located in the lumbar region of the back and radiates into the loins. Others have experienced diffuse abdominal pain or an epigastric pain, associated with the lumbar distress. In only the first of this series of five cases was all pain localized in the abdomen, and none experienced in the region of the kidney. In very mild cases there may be no pain. In the non-fatal cases actual pain ceases, in a few days, usually with the establishment of free diuresis. In those terminating fatally it continues until relieved by unconsciousness, which precedes death.

Hemoglobinuria is a constant symptom in all cases. It begins within a few hours of the onset, lasts a variable length of time measured by days, and terminates

either favorably by a gradual return to the normal or fatally by complete urinary suppression. In many of the non-fatal cases a distinct diuresis is noted independent of treatment. In two of our cases this was present. In the least severe case there was nothing noted except the hemoglobinuria and the light grade of jaundice. The urine varies from dark red to brownish black in color, contains sufficient albumin to completely coagulate it by heat, and shows large quantities of methemoglobin, oxyhemoglobin and some bile pigments (Geigy). The sediment is variable. It may be very small in amount and contain only a few epithelial cells and no whole or disintegrated blood elements in the mild cases. The sediment of the severer cases may be very rich, consisting of large quantities of disintegrated red cells (Wächter, Dütting, author), a variable number of washed-out, pale-appearing, but otherwise uninjured, erythrocytes (author), and granular, epithelial and blood casts (Wächter, Geigy), though for the most part the urinary condition is almost a pure methemoglobinuria. Traces of arsenic were found in the urine by Wächter and myself. In one case, that of Müller (1837), there was a generalized subcutaneous emphysema of uncertain origin; in all other reported cases jaundice was present. This begins soon after the onset of the symptoms. In our mild case it remained a distinct, yellowish jaundice. In those of any severity the skin soon turns a darker color, becoming brownish, coppery, sometimes greenish. The discoloration lasts usually some weeks, gradually fading when the coincident anemia becomes evident.

Nervous symptoms are present in all severe cases. In none of our cases were they severe. Stupor, semi-unconsciousness, later unconsciousness were present in our fatal cases. In Case 2 the patient at first had cramps in the legs; later he was very restless even when free from pain. There were no evidences of uremic twitchings or convulsions as reported by Coester and Becker. Exaggerated deep reflexes were not present in our cases nor reported so in others. Severe headache has been noted by some, though, as a rule, it is not so much complained of as the lumbar pain. Disturbances of vision, hearing and sensation have not been found.

The vascular system presents the picture of a severe blood dissolution. The anemia is grave. It consists seemingly of a solution of the hemoglobin content from the red cell more than a disintegration of the cell itself, although there is also a widespread destruction of the erythrocytes. The hemoglobin by Fleischl or Gowers may be relatively high. Rouleaux formation is retarded or prevented. There is no leucocytosis. Geigy reports in his first case the following blood findings: Reds, 885,000 to 920,000; hemoglobin (Gower), 57 per cent.; presence of disintegrated red cells and the shadows of non-disintegrated cells. No rouleaux formation. In his second case there were: Reds, 2,920,000; hemoglobin, 62 per cent.; small tendency to rouleaux formation, few disintegrated cells and few shadows of cells. Becker, in his case, found by smears large numbers of unstained shadows of red blood cells, much detritus and few white cells. This was the condition in two of our cases as noted in smears made by Dr. Hosmer. Diffuse bleeding is less common than might be expected from the condition of the blood and urine. Müller described large and small petechial spots on the extremities of his patient. Vallette described, in his second case, which resulted fatally, severe hemorrhages from the nose, gums, tonsils, bowels and genitalia. Blood in the stool

has been noted a number of times. But these conditions are the exception.

Moderate dyspnea on exertion is commonly described. Distinct air hunger in all of our cases was noticeably absent in spite of the severe blood destruction. It is mentioned, however, by Becker and Geigy. The stools are usually loose. Diarrhea may occur, but devoid of signs of inflammation as with other arsenic compounds. The stools are dark colored from the large amount of bile contained. Without doubt death is due largely to acute urinary suppression. Some patients, as stated above, have shown distinct uremic signs; the majority, however, have not. Of the 20 fatal cases here recorded, the most rapid death was that of Trost's fourth patient, who died in two days. Our second patient died in 60 hours from the time of exposure. Vallette's patient lived for thirty days before dying, which is the longest period of time noted. The average for 19 cases, in which the duration of the illness is stated, is 8.2 days. Of the 60 patients whose cases are recorded, 40 recovered; of these, the length of convalescence, that is, the length of time in hospital or kept from work, is given for 25. The longest is seven weeks, reported by Schindler; the shortest, four days, one case reported by Eitner and one by me. The average duration of illness was 17.3 days. In all of my cases a severe anemia lasted for some time after all other signs of illness had disappeared. Ultimate recovery without complications or sequelæ was the result in all cases.

TREATMENT.

Aside from measures taken to prevent the escape or formation of arseniureted hydrogen gas in laboratories or in the arts, the treatment in such cases is purely symptomatic. Three indications are present, along the lines of which much can be accomplished for the patient. First, the need of abundant fresh air. Oxygen should be of much benefit and should be used continuously. Secondly, the establishment of free diuresis to prevent the blocking of the uriniferous tubules by disintegrated blood cells and tubule epithelium. Toward this end all bland diuretics can be used, especially large quantities of water and milk, and often repeated saline enemas and warm baths. General supportive treatment, as in all prostration cases, is, of course, always needed. The use of digitalis need not be avoided for fear of a fatty myocarditis, because the latter, to any extent, does not exist. As a rule, the patient with suppressed urine will die. Active diuresis is a very favorable sign, and the majority of patients with polyuria will recover. The long-standing anemia is much benefited by iron.

THE EFFECT OF ARSENIURETED HYDROGEN GAS.

Among the earlier writers on this type of arsenical poisoning, Eulenberg²⁶ (1865) stated that after aspiration of the gas it was no longer to be demonstrated in the blood. Hermann²⁷ (1874) determined that arseniureted hydrogen was oxidized by the oxygen contents of the hemoglobin to arsenous acid, and from this fact he believed the poisonous properties of the gas due to its property of breaking up oxyhemoglobin. That arseniureted hydrogen is oxidized to arsenous acid by the blood and also by the liver tissue was later verified by Stricker²⁸ (1882). The reduction of oxyhemoglobin with the following destruction of the red blood cells was first noted by Bogomoloff²⁹ (1868) and Rabuteau³⁰ (1873). These observations were of importance because of their bearing on the previous discovery of Virchow³¹ (1847),

that all extravasated blood increased the formation of biliary pigments, and also the relation the action of the gas bore to other intoxications, infectious diseases, etc., which were accompanied by icterus without an apparent stasis of the bile outflow. That is, the icterus accompanying this form of poisoning belonged to the old group of hematogenous as opposed to hepatogenous icterus or icterus of pure stasis. Because of this relationship to the pathogenesis of icterus more is known of the specific effect of arseniureted hydrogen than otherwise would have been. In 1868 B. Naunyn³² conducted the first animal experiments with the gas and found the specific changes in the blood and hemorrhagic infarcts of the kidneys. His work led him to believe more strongly in the view then existing that bile salts were formed in the circulating blood as well as in the liver. The later reports of poison cases by Vallette, Ollivier, Trost, Wächter and Eitner added much encouragement to this belief. Shortly afterwards Stadelmann³³ began a series of animal experiments with toluylendiamin and arseniureted hydrogen to prove a common basis for both types of icterus. In many sections on dogs he found the gall bladders uniformly distended, the bile thick, tarry and tenacious and histologically the biliary radicles in the liver engorged with bile pigment and crystals. At the same time he noticed that the more severe the icterus the less bile there was in the intestine. It was clear to him, therefore, that stasis was obtained by the consistency of the bile itself, and that the icterus was as dependent on mechanical causes as any obstructive jaundice. The primary cause lay in the destruction of the blood, but the real cause was an overproduction of bile which clogged the biliary passages and allowed resorption into the lymph and blood spaces to occur. He termed this condition icterus from polycholia, or pleiochromia.

Minkowsky and Naunyn,³⁴ a little later, undertook a series of experiments with geese and ducks, because the anatomic relations between the portal vein and renal veins is such that the liver can be removed from the general circulation. Normal geese and ducks showed, after a short inhalation of arseniureted hydrogen gas, hemoglobinuria and a distinct increase of bile pigment excretion. Fowls from which the livers had been removed showed a hemoglobinuria, but no bileverdin in the urine. These experiments were seemingly conclusive that the formation of bile salts could not occur without the presence of the liver. Histologically they noted large cells containing fragments of red blood cells and clumps of hemoglobin scattered mainly through those organs, as the liver, spleen and bone marrow, where the blood current was slowest, which gave an iron reaction when treated with ferrocyanid of potassium and hydrochloric acid. Moderately rapidly this bile pigment became reduced and entirely disappeared. The probable formation is that of hemotoporphyrin from the free hematin, the former passing to the liver, where it is converted into biliary salts. These cells containing fragments of erythrocytes found in the liver capillaries were also noticed to stain green when treated with a 5 per cent. corrosive sublimate solution. The cells in the other portions of the body did not do this, and this fact was considered by both authors to mean an actual transformation into biliverdin as taking place in these cells found within the liver. They also assume that the hemoglobin dissolved from the cells and remaining free in the serum is transformed into bile salts by the liver cells. Ponfick³⁵ has asserted that the normally func-

tionating liver will take care of one-sixtieth part of the total hemoglobin content. Whenever destruction of the red cells liberates an amount which exceeds this quantity icterus will result. Clinically at least, it would seem that this condition does not hold true and that something besides a destruction of blood is needed to explain an icterus, especially when associated with little or no ascertainable anemia. Many have held that a second factor is necessary, a functioning disturbance of the liver cells themselves, such as is assumed in case of the kidney cell which permits an albuminuria. It is easy to assume the possibility of disturbed function on the part of the liver cells from the effect of so intense a toxic agent as arseniureted hydrogen.

The more recent work of Eppinger,³⁶ which is based on careful histologic preparations that have allowed the walls of the bile capillaries to be plainly seen and have demonstrated imperfect lymph spaces between the bile capillaries and the cells, has again added more weight to the purely mechanical theory of icterus. He describes in these types of jaundice obstruction of the capillaries, often a sinuosity, varicosity, at times a rupture of the walls, and as a result the bile escapes into the lymph spaces and thence into the blood. This obstruction of the capillaries is often of the nature of distinct casts or thrombi and does not concern the bile passages. In the main this work has been confirmed by Minkowsky and Winckelmann,³⁷ although they do not find these lesions in all forms of jaundice examined, especially of infectious jaundice. In these cases the former believes a specific action of the cell the primary cause, so that he still groups icterus into two large classes—the true obstructive type in which mechanical obstruction is the underlying cause, and the toxic, cyanotic and nervous type, in which a disturbed cell function is the determining factor.

In brief résumé, arseniureted hydrogen is an exceedingly toxic compound of arsenic which acts on the animal body in a way distinct from that of other arsenic salts. The principal organs attacked are the blood and the kidneys. The lesions of the former consist of a rapid dissolution of the hemoglobin content and an actual disintegration of the red cells. The effect on the latter, as seen postmortem, is an intense, diffuse, hemorrhagic, degenerative process, involving the convoluted tubules most severely and the glomeruli least and showing but slight reaction toward regeneration. The jaundice which is present in all cases is probably of an obstructive type in the main, though it is highly probable that disturbed liver cell function also plays a certain rôle in its formation.

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Clinical Notes

INSPECTION OF THE JUGULAR VEIN; ITS VALUE AND ITS LIMITATIONS IN FUNCTIONAL DIAGNOSIS.

A CRITICISM BY DR. HIRSCHFELDER AND A REPLY BY DR. MCCASKEY.

I. A CRITICISM.

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The subject of heart-block and the recent additions to the knowledge of the allied functional disturbances of the heart and of the so-called cardiac neuroses have aroused a great deal of interest in the revelations from tracings of the venous pulse and polygraphic tracings. Although with appropriate apparatus¹ these are somewhat less difficult to obtain than are good radial pulse tracings, some form of rather expensive polygraph is necessary, and about half an hour is required to obtain the desired record.² Nevertheless so much information is to be gained by what they show that this procedure can scarcely be omitted from the modern routine examination of heart cases.

It is, therefore, natural that efforts should be made to minimize the labor involved in such investigation, and in this regard the recent contribution of Dr. G. W. McCaskey³ marks an attempt toward simplicity. By means of the Mackenzie receivers⁴ placed on the jugular vein and apex and attached to tambours bearing levers in the usual manner the pulsations from these areas are transmitted to the levers, which are brought as close as possible to each other; and from the respective movements the events of the cardiac cycle are deciphered. He does not state what advantage this visual method has over simply watching the pulsation of the jugular vein while feeling the pulse in the carotid with the finger.

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