

HIGGINS (F. A.) & OGDEN (J. B.)  
*Compliments of the Authors.*

# TRAUMATIC GLYCOSURIA

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Observations Made in Two Hundred and Twelve  
Cases of Head Injuries.

BY

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## TRAUMATIC GLYCOSURIA.

### OBSERVATIONS MADE IN TWO HUNDRED AND TWELVE CASES OF HEAD INJURIES.\*

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EVER since the time of Claude Bernard, who first experimentally demonstrated the existence of the so-called sugar centre in the floor of the fourth ventricle, head injuries have been recognized as playing a certain part in the etiology of some cases of diabetes. In addition to permanent glycosuria following traumatism of the head, there is another form observed by some writers, and of which a number of cases have been reported. This last is merely transitory, and comes on directly after the traumatism, or in a few days. On the other hand, the permanent form of glycosuria occurs at a period of weeks, or even months afterwards.

In this article very little work has been directed towards this last form. The work recorded here was undertaken with the purpose of establishing whether any relation exists between various head lesions resulting from traumatism and transitory glycosuria. It is obvious that this could be done only by following out a considerable number of cases such as would be seen in a large municipal hospital. Accordingly, the work has been performed, with the permission of the surgeons of the Boston City Hospital, upon all cases of head injuries, regardless of severity, admitted to the hospital wards during the thirteen months beginning December 1, 1893, and ending January 1, 1895, com-

\* Being one of the two papers receiving a Second Lyman Prize for the year 1894. This Paper will appear in the Boston City Hospital Medical and Surgical Reports, Sixth Series.

prising, in all, 212 separate cases. The observations are the results of frequent and systematic examinations of the urine, obtained as soon as possible after the injury, and continuing from time to time during the patient's stay at the hospital. This was done in order to ascertain if any connection existed between the nature of the injury, whether mild or severe, and the appearance of sugar in the urine. Further, to see if such a condition when it occurred could render any assistance in diagnosis, especially in those not infrequent cases in which the diagnosis may be obscured or doubtful, such as many so-called fractures of the base of the skull, resulting in recovery, with no other prominent symptoms than temporary unconsciousness and hemorrhage from the ear. The pathology of the disease is not entered upon at all, but a number of cases in which autopsies were performed are reported in full.

First will be considered the literature of permanent glycosuria, and second, that of transitory glycosuria.

#### LITERATURE.

The literature of permanent traumatic glycosuria is comparatively meagre, yet traumatism is generally mentioned as one of the etiological factors in most works on diabetes.

A few examples of traumatic glycosuria are found in the works of Seegen, Fritz, Rechlighausen, Fischer, Mahe, Tood, Cyr, Itzigsohn and Leydon; but Charcot is of the opinion that many of these are more often cases of persistent glycosuria than of true diabetes.

Lyman<sup>1</sup> says, "Injuries (and tumors), especially if they involve the fourth ventricle, are often accompanied by the development of diabetes."

Strümpell<sup>2</sup> says, "Glycosuria may result from severe concussion of the brain and fracture of the skull."

Tyson<sup>8</sup> says, "Excepting the injuries to the nervous system, which are known to cause diabetes, our knowledge of its causes are not precise. With regard to the former, it is well known that blows upon the skull, with or without fracture, and concussions, communicated to the brain, spinal cord and vaso-motor centres in other ways, as by falls, are such causes."

Griesinger<sup>4</sup> found that 13 out of 225 cases which he collected were of traumatic origin.

Luce<sup>5</sup> reports the case of a healthy lad who fell while skating, striking the back of his head heavily on the ice, and died shortly afterwards of diabetes.

Friedrichs,<sup>6</sup> out of a large number, could only trace eight cases of diabetes to traumatism.

Bacelli<sup>7</sup> reports the case of a young man who became diabetic after a concussion of the brain. At the autopsy a necrobiotic point was found in the centre of the pons-Varolii.

Vogel<sup>8</sup> reports a case of a fireman upon whose neck a beam fell. In a few weeks there followed a severe glycosuria ending in death. At the autopsy nothing abnormal was found in the brain, and it is thought that diabetes resulted from concussion of the spine.

Senator<sup>9</sup> says that mechanical injuries are among the most important of exciting causes, such as concussion of the brain and spinal cord, or even of the whole body. Glycosuria usually makes its appearance in a few hours or days after the infliction of the injury, rarely not until later.

Lasegue<sup>10</sup> reports a case of glycosuria occurring three months after the accident, in a man who fell down stairs, causing cerebral concussion.

Bernstein-Kohan,<sup>11</sup> out of 45 cases, traced 25 to head injuries, and reports that sugar does not always appear immediately after the injury. If the sugar appears early, it is very apt to be mild. If late, it may be severe and rapidly fatal.

Spencer<sup>12</sup> says, "Injuries of the head and spinal cord are often the cause of sugar in the urine. The sugar may last for a few hours only, or for a few days. As a rule, it quickly disappears, but in some cases the sugar persists, and the patients begin to be diabetic from the time of the injury."

Brouardel and Richardiere,<sup>13</sup> in an article on "Traumatic Diabetes from a Medico-legal Point of View," state that traumatism is a well-recognized cause of diabetes, and that in a considerable number of cases in head injuries, examination of the urine reveals sugar when it has been before unsuspected.

This completes, in brief, a summary of the literature touching upon the subject of permanent traumatic glycosuria, and is sufficient to establish the fact that traumatism does play a more or less important part in the etiology of diabetes. With respect to traumatic glycosuria of the transitory form, it has been the object of much less notice on the part of medical writers and investigators. In connection with this form, the work reported in this article has been principally performed. In the works of Alladoff, Schiff, Pavey and Eckhardt, this subject receives but a passing notice.

Redard<sup>14</sup> says, "A glycosuria uniformly presents itself after all forms of traumatism of the head, whether accompanied by fracture or not. It may show itself almost immediately after an accident." He quotes eight cases where it appeared in two days, and a number of other cases where it appeared after a number of weeks. He affirms that sugar, if carefully sought for, is nearly always found.

Robin<sup>15</sup> reports a case of temporary glycosuria following cerebral concussion, sugar lasting four days.

De Pietro<sup>16</sup> says that after wounds and injuries of the head, glycosuria may last from two to eleven days, according to the severity of the lesion. That it ap-

pears later and lasts longer in fractures than in simple wounds.

Nuzzi<sup>17</sup> says that glycosuria is more or less constant after head injuries. The time of appearance and the quantity of glucose varies greatly. His results are generally negative. In 115 observations on 39 patients he found glycosuria only three times.

Oppenheim and Eisenlohr<sup>18</sup> have observed the transitory form of glycosuria in a few cases.

Buch<sup>19</sup> reports twenty cases with literature, in which injuries occurred to parts of the head, the glycosuria following, being of the transitory form.

Lancereaux<sup>20</sup> says that glycosuria following traumatism is much less serious than the other varieties. It is temporary, it may disappear in a few days, and it never continues longer than a few months.

This concludes a short review of the literature of transitory glycosuria. It consists merely of mere mention of the existence of such a condition by some writers, and reports of a limited number of cases by others. There seems to have been no attempt made to investigate any considerable number of cases with head injuries, or to trace any connection between the glycosuria and the nature of the head injury. Redard attempted to find a connection between the appearance of pus in the wound of the head and glycosuria, but that any connection between the two existed was denied by De Pietro.

We have tabulated the results of the observations on 212 cases, and have arranged them in classes according to the nature of the head injury, without regard to lesions in other parts of the body; yet whenever there have been such lesions, they have been noted both in the tables and in the description of individual cases. The tables will be found in the paper as published in the City Hospital Report. The description of the individual cases follows.

CLASS 1, includes the simple scalp wounds and other minor head injuries.

CLASS 2, scalp wounds with bone exposed.

CLASS 3, cases of concussion, meaning those followed by loss of consciousness without fracture.

CLASS 4, includes fractures of the vault of the skull.

CLASS 5, fractures of the base of the skull.

#### CLASS I.

CASE 24, CLASS 1. J. D., male, age forty, laborer. Service of Dr. Cushing. Nine days before entrance was struck on the head by an iron bar, sustaining a scalp wound three or four inches long. There were ten stitches taken in the wound at that time. Three days later erysipelas of the face and scalp developed. On entrance, beside the erysipelas, a discharging sinus was found at one point in the unhealed scalp wound. The patient was discharged on the fifteenth day, the erysipelalous blush having entirely disappeared, and only a very slight discharge from the wound.

*Urine.*—The urine was examined the day following entrance, but no sugar found. Two days later, (twelfth day after injury and ninth day after the appearance of erysipelas) the urine had a specific gravity of 1.020, and contained a slight trace of sugar, it being, however, too slight to quantitate. This trace of sugar continued for two days, then disappeared, and was not found again during his stay in the hospital.

There is obviously some doubt as to the cause of the sugar in this case. It appeared for the first time twelve days after the injury, and at a time when the erysipelas was rapidly improving. It would appear, however, as if the erysipelas had an exciting factor in the production of the sugar, yet it may have been due directly

to the injury, even though the sugar did not appear for twelve days. Brouardel and Richardiere report four cases of injury to the head where the sugar did not appear until from one to two weeks after the injury.

CASE 27, CLASS 1. W. E. T., male, age four years. Service of Dr. Post. Was run over by an express-wagon, and on entrance was found to have a hematoma over the left frontal eminence, beside a lacerated wound of left ear and contusion of left shoulder. The wound of the ear was dressed antiseptically. At no time were there any head or nervous symptoms. The patient was discharged on the twelfth day, apparently in excellent condition.

*Urine.* — The urine, obtained nine and a half hours after the injury, was found to have a specific gravity of 1.025; albumin, the slightest possible trace; sugar, 2.92 per cent. Fermentation by yeast was very active. Two days later the urine had a specific gravity of 1.035; albumin, slightest possible trace; sugar, a very faint trace. A specimen obtained on the fifth day after the injury showed a complete disappearance of the sugar. Repeated examinations of the urine while the patient remained in the hospital, failed to show any trace of sugar after the fifth day.

CASE 52, CLASS 1. J. O'B., male, age forty-seven, janitor. Service of Dr. Watson. The patient, while intoxicated, fell from a roof, a distance of ten feet, sustaining a scalp wound one and a half inches long, running transversely between the left parietal eminence and the median line. Several contusions about the left shoulder and right side. The pupils were equal and reacted to light. Mental state dubious, because of the alcoholic condition. Scalp wound sutured and dressed antiseptically. The following day the mental condition was good, and he was feeling very well ex-

cept for lameness resulting from the fall. The patient was discharged well on the seventh day.

*Urine.* — The urine which was passed about eighteen hours after the injury had a trace of sugar, this being the only time that it was found. Three months after the injury a specimen of urine was obtained from the patient and found to contain no sugar.

CASE 73, Class 1. P. F., age twenty, female. Service of Dr. Gavin. Was confined in November, 1894. While suffering from puerperal mania, which developed fifteen days later, she jumped from a third-story window (thirty feet) striking on the ground. She was brought to the hospital suffering from an incised wound of left super-orbital ridge, three-quarters of an inch in length, bone not exposed. Also on the inner aspect of the left breast a small wound one-half an inch long and a quarter of an inch deep. Milk expressed from both breasts. The wounds were dressed antiseptically. For the first few days the breasts were relieved of their secretion by means of a breast-pump. The patient remained delirious during her stay in the hospital. The wounds entirely healed, so that she was discharged on the sixth day.

*Urine.* — On the day after entrance a trace of sugar was found in the urine. The amount of sugar increased considerably in the next few days, for on the sixth day after entrance nearly one per cent. was found. There was not only a reduction of copper in Fehling's solution, but also a noticeable fermentation with yeast.

CASE 74, CLASS 1. E. M. S., age thirty-eight, female. Service of Dr. Burrell. Was confined in March, 1894. Nine months later was struck on the head and face in a quarrel with her husband. On examination she was found to have a large hematoma over the left parietal and frontal eminences and extending down onto the left cheek. There was marked

swelling of nose and about the left eye, sufficient to close it. A small contused wound behind left ear, also on left cheek. The arms, legs and lower part of trunk were covered with small excoriations and bruises. There was also a fracture of the second phalanx of the right ring-finger. There was no paralysis or head symptoms. As the patient had been nursing her child up to the time of entrance to the hospital, the breasts required massage during the first twenty-four hours only, there being no trouble afterward.

*Urine.* — The first specimen of urine, obtained about twelve hours after entrance, was found to have a specific gravity of 1.018, a large trace of albumin, and to contain a slight trace of sugar. After forty-eight hours the sugar had increased to a distinct trace, yet too slight to be quantitated, the urine having a specific gravity of 1.026, and containing a very slight trace of albumin. There was a definite fermentative reaction obtained by yeast. An examination of the urine made ten days after entrance showed a specific gravity of 1.023, a very slight trace of albumin and a complete disappearance of the sugar. Repeated examination, made later, failed to show the presence of sugar.

(Patient still in hospital, at the time of writing.)

In the consideration of these last two cases, we are confronted by the question, Have we to do with a lactosuria or a temporary glycosuria as a result of injury to the head and a general "shaking up"? In both cases, each was nursing a young child up to the time of injury, and according to Ord,<sup>21</sup> lactose appears in the blood during lactation. Blot,<sup>22</sup> de Sinetz,<sup>23</sup> Hoffmeister,<sup>24</sup> Kaltbach,<sup>25</sup> Halliburton<sup>26</sup> and Hammersten,<sup>27</sup> say that lactose appears in the urine, as such, although Ord,<sup>21</sup> Moritz<sup>28</sup> and Voit<sup>29</sup> seem to have found

it appearing in the urine as glucose, yet Moritz<sup>80</sup> later asserts the probability of a lactosuria.

In distinguishing between glucose and lactose we find that, according to Hammersten, the latter is not fermentable with pure yeast, yet both reduce copper. If then, this be true, although the non-fermentation of lactose is disputed by Halliburton, we may have to do, in these two cases, with a glycosuria, either alone or coincident with a lactosuria.

## CLASS II.

CASE 87, CLASS 2. D. C., age twenty-nine, male. Service of Dr. Bolles. Fell twenty-five feet from a staging striking on right side of face, causing a wound three inches long, beneath which the malar bone, zygoma and the coronoid process of jaw were fractured. In addition, there was a small wound one inch long, with bone exposed in middle of forehead and a Colles fracture of left wrist. Patient was unconscious, remaining so several hours, following which was delirium lasting most of the time till death; pupils reacting, but unequal; no paralysis. In dressing, a number of small pieces of bone from the face were removed. The wounds healed almost throughout by primary union. On the sixth day a right facial paralysis was first noticed, with mouth drawn to the left, probably due to injury of the facial nerves. At night on the same day, patient had difficulty in swallowing, and on the next day developed a pronounced tetanus in the facial muscles, with spasm of the tongue. Following this he failed rapidly and died on the eighth day.

*Autopsy.* — Brain normal, with dura adherent to the bone at the base. No fracture about the head except in the bones of the face. Right kidney was ruptured, with hemorrhage into the suprarenal capsule.

There was also hemorrhage into the capsule of the liver, on right lobe under surface. There was an acute splenic tumor, congestion of lungs, and a few small patches of sclerosis in aorta and coronary arteries.

*Urine.* — An examination of the urine passed about twelve hours after the accident, disclosed the presence of 1.04 per cent. of sugar, with a specific gravity of 1.020 and a large trace of albumin. Repeated daily examinations of the urine gave a smaller percentage of sugar each day up to the sixth, when it had entirely disappeared. A positive test by fermentation.

As on the sixth day the first symptoms of tetanus appeared, it is perfectly evident that the glycosuria could not have been caused by this complication. To which of the other lesions it was due it is impossible to determine.

CASE 112, CLASS 2. J. M., male, age fifty. Service of Dr. Monks. Five days before, fell in getting off a moving electric-car, striking head on a post. At time of entrance, on patient's head were two irregular, suppurating cavities in scalp, the first over vertex about one by one and a half inches; the second over left parietal eminence, about one-half by two inches, appearing as if the flesh had been torn away, leaving the bone uninjured, exposed beneath. In six days erysipelas of the face and scalp developed, following a chill, headache and a rise in temperature the day before. Patient did well until the twenty-second day, when without apparent cause he suddenly became unconscious and died.

*Autopsy.* — There was no evidence of fracture of the skull; great excess of serous fluid in the subarachnoid spaces and in the ventricles. The veins of the brain were distended with dark fluid blood. The puncta cruenta were prominent; no meningitis. Brain substance firm, and on section no evidences of hemor-

rhage or pathological changes. Other organs of the body normal, except for a moderate edema and congestion of the lungs.

*Urine.* — The urine of this patient, from the time of entrance till his death, was examined frequently, and at all times was found to be above 1.030 in specific gravity and to contain a large amount of sugar, the greatest amount at any one time being 5.55 per cent., varying between that and four per cent. There was active fermentation at each examination.

As the erysipelas developed on the sixth day, it may at once be excluded in considering the cause of the glycosuria. It is possible, in view of the early presence of a large quantity of sugar in the urine, continuing undiminished several weeks till death, that we have to do in this case with a diabetes existing prior to the injury. The previous history of the patient with respect to thirst, frequent micturition, etc., is, however, entirely negative. Charcot says that cases of persistent glycosuria following blows on the occiput are more common than, and are apt to be mistaken for, cases of true diabetes. It seems probable, then, that this may be a case of that kind.

CASE 119, CLASS 2. M. R., male, age fifty-three. Service of Dr. Cheever. Knocked down by a team in the street, causing over occiput an irregular lacerated wound three inches long, bone exposed. In addition, there was a fracture of one rib. Patient was very restless, with a mild delirium at times for several days. The wound united well by primary union, and on the twelfth day he was removed from the hospital.

*Urine.* — The first urine examined was passed ten hours after the injury. At that time the specific gravity was 1.033, with a trace of albumin and 3.84 per cent. of sugar. Two days later there was four

per cent. of sugar present, with a specific gravity of 1.043. From this time on until the patient's discharge the sugar gradually decreased to 1.91 per cent. at the last examination on the twelfth day. There was a pronounced yeast fermentation at all times.

CASE 122, CLASS 2. G. A., male, age eleven. Service of Dr. Burrell. While crossing the railroad track was struck by a locomotive, causing a large hematoma over occiput, with a scalp wound two and a half inches long, bone exposed beneath. In addition, there was a compound fracture of the right leg and a bad crush of right arm necessitating amputation above the elbow. The boy suffered from profound shock, remaining unconscious for about twenty-four hours, followed by delirium lasting four to five days. He is now making an excellent recovery, still remaining in the hospital.

*Urine.* — The first urine was passed twelve hours after the injury. It contained a trace of albumin, a very small percentage of sugar, and had a specific gravity of 1.028. On the third day the trace of sugar had disappeared, and frequent examinations up to the present time have not detected its presence again.

### CLASS III.

CASE 147, CLASS 3. J. S., male, age twelve. Service of Dr. Gavin. Was thrown from a carriage in a "runaway" accident, striking on his head. He was picked up unconscious, remaining in this condition for about two hours. On arrival at the hospital, there was found a hematoma over the right parietal and occipital regions. No depression or fracture of the bones could be made out. Pupils were equal and reacted to light. He complained of slight pain in the head, this,

however, being the only subjective symptom. The patient was discharged relieved on the eleventh day, in a very good general condition.

*Urine.* — The urine was unfortunately not examined for thirty-six hours, at which time 1.2 per cent. of sugar was found. On the fourth day after injury it was found that the sugar in the urine had diminished to 0.3 per cent.; on the sixth day only a faint trace; and a complete disappearance on and after the ninth day. At each examination of the urine the fermentation test with yeast was tried with a satisfactory reaction as long as the sugar remained. At no time were we able to get a reaction for acetone or diacetic acid. On the thirty-seventh day after the injury another specimen of urine was obtained from the patient, and was found to be free from sugar.

#### CLASS IV.

CASE 169, CLASS 4. W. M., male, age forty. Service of Dr. Gavin. Shot himself in the head during a fit of melancholia. The patient was brought to the hospital in a semi-conscious condition, having a perforating wound one and one-half inches above and same distance back of the right ear. The pupils were equal and reacted to light; no paralysis. The wound was probed by Dr. Gavin, who found an opening having jagged edges through the skull. An effort to find the bullet was unsuccessful. Two days later the patient regained consciousness, and at this time slight paralysis on the left side, with deviation of the eyes to the right was noticed. On the fifth day became delirious and noisy, this continuing for four days. There was retention of urine on the tenth day, and at this time there was a sero-purulent discharge from the right ear. The patient's mental condition had im-

proved somewhat, and the general condition remained pretty good to the twenty-eighth day, when he became unconscious; the retention of urine had given way to incontinence, still paralysis of left side. Death occurred on the twenty-ninth day.

*Autopsy.* — A well-marked cicatrix situated two inches behind and one and one-half inches above external angular process. On removing the scalp a circular opening through skull was found. A fracture one-half inch behind coronal suture, penetrating the great wing of the sphenoid bone. Bullet was found just inside the opening in the skull and over the third frontal convolution just anterior to the ascending limb of Sylvius. This frontal convolution was softened and destroyed. There was no abscess cavity at this point.

*Urine.* — An examination of the urine, made seventeen hours after the injury, had a specific gravity of 1.025; albumin, slightest possible trace; sugar, a trace, too slight to be quantitated. Repeated examinations were made during the life of the patient, but no sugar was found at any time after the first examination.

CASE 191, CLASS 4. G. M. R., male, age fourteen. Service of Dr. Watson. Was struck on the head by the shaft of a planing-machine, sustaining a lacerated wound extending from the bridge of nose to supraorbital ridge of frontal, destroying left eye, and involving the nasal, frontal, malar, and possibly superior maxillary bones in compound comminuted fracture. On entrance to the hospital was conscious, pulse rapid but of low tension. The patient was operated upon by Dr Monks, who enucleated all remains of the eye, removed fragments of bone, thoroughly cleansed and dressed the wound antiseptically. The next day, while dressing the wound, a rather profuse discharge of sero-sanguinous matter was observed. There followed a good recovery, and he was discharged on the nineteenth day.

*Urine.* — An examination of the urine, twenty-four hours after the injury, showed specific gravity of 1.035, slightest possible trace of albumin, 0.85 per cent. of sugar. The fermentation test was active. During the patient's stay in the hospital, unfortunately the urine was not examined again; but five months after the injury the patient returned for observation, and the urine was found to have a specific gravity of 1.020, slight trace of albumin, and contained no sugar.

CASE 180, CLASS 4. M. K., female, age fifty-two. Service of Dr. Bolles. In an encounter with a burglar was struck twice on the head with an unknown implement. She remained in an unconscious condition about four and a half hours. On entrance, the patient was found to be a fleshy woman with a scalp wound about three inches in length over the right frontal eminence, and a crack in the bone running forward. No depression of bone. The wound was treated antiseptically. No pre-existing history or symptoms of diabetes in patient or in ancestors. An uninterrupted recovery followed, without any notable subjective symptoms. The patient was discharged on the nineteenth day.

*Urine.* — Eighteen hours after entrance, specific gravity 1.040; albumin, very slight trace; sugar present (not quantitated). The amount of urine passed in the first twenty-four hours was 1,080 c. c.

Third day, amount, 960 c. c.; specific gravity 1.037; albumin, very slight trace; sugar, 2.5 per cent. Marked fermentative reaction.

Fourth day, amount, 1,260 c. c.; specific gravity 1.024; albumin as before; sugar, 1.19 per cent. Marked fermentative reaction.

Seventh day, amount, 1,500 c. c.; specific gravity 1.016; albumin as before; sugar, 0.35 per cent. Very slight fermentation.

Ninth day, amount, 1,800 c. c.; specific gravity 1.016; albumin as before; sugar present, but too slight to quantitate. No fermentative reaction.

Eleventh day, amount, 1,380 c. c.; specific gravity 1.028; albumin, a slight trace; sugar, a trace, too slight to quantitate.

Twelfth day, amount, 1,830 c. c.; specific gravity 1.030; albumin, a very slight trace; sugar, 3.84 per cent. Fermentation very active.

Thirteenth day, amount, 1,260 c. c.; specific gravity 1.042; albumin as before; sugar, 4.16 per cent. Fermentation very active.

Fifteenth day, amount, 650 c. c.; specific gravity 1.042; albumin as before; sugar, 5.43 per cent. Fermentation very active.

Sixteenth day, amount, accidentally lost; specific gravity 1.036; albumin as before; sugar, 2.38 per cent. Fermentation active.

Nineteenth day, amount, 1,350 c. c.; specific gravity 1.033; albumin, very slight trace; sugar, 1.29 per cent. Fermentation active. Discharged on this day.

Acetone and diacetic acid were not obtained at any time, although tested for at each examination of the urine.

There are some points in this case which would tend to show a pre-existing permanent diabetes, namely, a corpulent individual, the continued presence and invariable large percentage of sugar. On the other hand, we could get no history of diabetes (pruritis, excessive thirst, a noticeable increase in the daily amount of urine, etc.). The daily amount of urine while in the hospital, was generally below 1,500 c. c. (although this might well be in a case of permanent diabetes).

CASE 181, CLASS 4. F. R., male, age nineteen. Service of Dr. Bolles. During a quarrel he was struck on the head with an iron bar about an inch in

diameter. His mind was perfectly clear after the accident. On entering the hospital, there was found a scalp wound about three inches in length over the right temporal bone, with an exposure and depression of bone. The depression extended over an area of about half an inch and about one-eighth of an inch in depth. There were no subjective symptoms except for rather severe headache. The temporal bone was trephined, and several small pieces of bone removed. No subjective symptoms. A good recovery followed, and he was discharged on the nineteenth day.

*Urine.* — At the first examination, made three days after injury, there was a specific gravity of 1.028, and no sugar or albumin present. On the sixth day the urine had a specific gravity of 1.030 and a very slight trace of albumin and sugar. There was a complete disappearance of the sugar two days later, and no recurrence during his stay at the hospital.

CASE 183, CLASS 4. J. R., male, age twenty-four. Service of Dr. Bolles. Was struck on the head by a large piece of coal which fell from a staging above. He was knocked down, and was insensible for only a few moments. He then walked home without assistance. Three hours and a half later he became unconscious, and was brought to the hospital in this condition. Examination showed a well-developed man. Pulse rapid (160); respiration 40, and simulating the Cheyne-Stokes character. Both pupils dilated; left more than right, and reacting sluggishly to light. A small scalp wound at the coronal suture, in the median line. All extremities were rigid, relaxing momentarily at times. The operation of trephining was performed by Dr. Bolles, who removed a button at the point of scalp wound and another one over the course of the left middle meningeal artery, but nothing was found in either place to account for the symptoms.

Death occurred fifteen hours after the injury. There was no autopsy.

*Urine.* — About eight hours after the injury, the urine was drawn by catheter, and found to have a specific gravity of 1.033; albumin, a very slight trace; sugar, a faint trace (too slight to quantitate). Only one examination was made before death.

#### CLASS V.

CASE 212, CLASS 5. C. A. L., age forty-two, male. Service of Dr. Watson. Was thrown out of carriage one-half hour before entrance. When seen first, there was slight stupor, from which he could be aroused sufficiently to give name and age, but relapsed immediately on being allowed to remain undisturbed, and at the end of another hour was totally unconscious, soon becoming delirious. Over right parietal region was a large swelling beneath which nothing could be felt; hemorrhage from left ear; no paralysis, knee-jerks slightly increased, examination otherwise negative. About three hours after the accident an incision was made over swelling, revealing a crack in the bone, running downwards and forwards towards the base. Bone was trephined, finding the dura lacerated with considerable hemorrhage, necessitating tying the posterior branch of the middle meningeal artery. Patient did not recover consciousness after the operation. He continued noisy and delirious, dying forty-five hours after the accident.

*Urine.* — It was possible to obtain only one specimen of urine from the patient. A small quantity was drawn by catheter sixteen hours after the injury. At that time it contained a very slight trace of albumin, with a specific gravity of 1.030; and a trace of sugar was found by Fehling's and the fermentation tests.

CASE 201, CLASS 5. J. S., age thirty-seven, male. Service of Dr. Bolles. Twenty-four hours before entrance fell into the hold of a vessel, striking on head. At entrance unconscious, very restless and delirious; no paralysis. Over occiput, a scalp wound three inches long, bone exposed beneath, in which a fracture was found extending into base beyond limits of wound. No depression or fissure. There was a bloody serous discharge from right ear, also a slight exophthalmos of right eye. Patient continued delirious, and died thirty-four hours after the injury. No autopsy.

*Urine.*—Catheter specimen was obtained twenty hours after fall. Specific gravity was 1.027, containing a trace of albumin, and sugar to 1.25 per cent. This was the only examination made.

CASE 208, CLASS 5. G. L., age twenty-three, male. Service of Dr. Bradford. Shortly before entrance fell twenty feet, striking on frozen ground. No external signs of violence; paralysis of right arm and leg. Unconscious, delirious, and very restless, lasting for about six days without other special subjective symptoms. Patient then made gradual improvement mentally and in the use of right arm and leg; and on the twenty-ninth day, being up and walking about, was discharged.

*Urine.*—On the third day after the injury, the urine was found to contain a very small amount of sugar with a slight trace of albumin, and a specific gravity of 1.030. This was the only time that sugar was found present.

CASE 193, CLASS 5. C. H. C., age fifty-four, male. Service of Dr. Monks. On the morning of entrance patient was struck on the head by a piece of falling machinery; was brought to the hospital unconscious, cyanotic; no paralysis; respiration slow and stertorous; pupils fixed, and there was slight external stra-

bismus of both eyes. Over right parietal and temporal regions was a large hematoma, beneath which nothing could be distinguished. There was no hemorrhage from ears, nose or mouth. An immediate operation was performed; on removing the flap over an area two inches in diameter, the bone was found comminuted and depressed, with line of fracture extending into nose. Beneath, the dura was badly lacerated. Between the bone and dura was a large clot from the middle meningeal, which was ligated. Fragments of bone and the clot were removed, and the wound closed and drained. Patient failed rapidly, dying nine hours after the injury. No autopsy.

*Urine.* — The only specimen of urine obtained was drawn by catheter about six hours after the accident, immediately before operation. It had a specific gravity of 1.022, the slightest possible trace of albumin, and 2.17 per cent. of sugar.

CASE 196, CLASS 5. T. O'C., age twenty-seven, male. Service of Dr. Monks. Twenty hours before entrance to hospital was assaulted in an unknown manner. Patient was unconscious, very restless and delirious, with no marks of injury about head. There was evidence of old hemorrhage from left ear, but otherwise physical examination was negative. Death occurred about thirty hours after injury.

*Autopsy.* — Over left occipito-parietal region there was considerable infiltration of the scalp over an area four inches in diameter. Skull was fractured, beginning at about one inch to the left of the junction of the occipital and two parietal bones and extending to the left, downwards and forwards, across parietal and temporal bones, through the petrous, and stopping near the middle of squamous portion. There was no fissure or depression. Surface of brain vessels markedly injected with little free blood within arachnoid spaces.

At the base pia moist and opaque, covered with a thick exudation of pus and serum. To a less degree, some exudation found along sulci from base to vertex. Base of frontal lobes bruised over an area one inch in diameter and one-quarter inch deep, also slight bruising at tip of left temporal lobe. Substance of brain moist and soft. Kidneys slightly enlarged, injected and granular. Organs otherwise normal.

*Anatomical Diagnosis.* — Fracture base of skull, contusion of brain and purulent meningitis.

*Urine.* — A catheter specimen was obtained immediately after entrance, twenty hours after the injury. The specific gravity was 1.030; it had a large trace of albumin, and sugar was present to less than one per cent., too small to determine quantitatively.

#### RESULTS.

Total number of cases examined 212; cases of glycosuria 20, or 9.43 per cent.

Class I. Number of cases 84; glycosuria 5, or 5.95 per cent.

Class II. Number of cases 43; glycosuria 4, or 9.3 per cent.

Class III. Number of cases 40; glycosuria 1, or 2.5 per cent.

Class IV. Number of cases 24; glycosuria 5, or 20.8 per cent.

Class V. Number of cases 21; glycosuria 5, or 23.8 per cent.

These figures show the results obtained in percentages of cases having sugar, taken both collectively and as they have been arranged in classes.

Assuming that of all the twenty cases which had glycosuria, none were diabetic before the injury, there is then a percentage of 9.43 in general for all classes of head injuries. This is fully as high as could be expected, considering the large proportion of the whole number of cases (167 out of 212) in Classes 1, 2 and 3. These would generally be considered as minor accidents.

It does not seem unfair to argue upon the assumption that in all the patients the glycosuria occurred as

the result of the trauma and that they were not diabetic before. This seems especially reasonable when the fact is taken into consideration that of 1,563 patients, the whole number of accident cases admitted to the hospital for the same thirteen months during which the head cases have been studied, no case apart from those with head injuries was found to have glycosuria. As it is, there are only three cases out of the whole number — J. M., Case 112, Class 2; M. R., Case 119, Class 2; and M. K., Case 180, Class 4 — in which there can be any question. From a careful study of these after the accidents and taking into consideration their previous histories, it seems very probable that a permanent glycosuria was consequent upon the head injury, rather than that a diabetes existed previously.

With the exception of Class 3, which shows a surprisingly small percentage of sugar cases, there is considerable increase in the number with each higher class. This is, as would naturally be expected, very noticeable in the increase of the last two over the preceding one. The difference between these two considered together, apart from the other classes, is not sufficient to be of any marked significance. It has been of considerable interest, however, to consider them separately in this paper.

In general, then, it can be said that all classes of head injuries taken together, about 10 per cent. manifest glycosuria as the result of traumatism, while the severe cases, fractures both of the vertex and base, from 20 per cent. to 25 per cent. have glycosuria.

Sugar may be present in the urine following any head injuries, however slight. It is present much more frequently following severe injuries. From a diagnostic standpoint it is difficult to see how the presence of a glycosuria can render any assistance.

## INJURIES TO THE SPINE AND BACK.

During the period over which our observations have extended, a limited number of cases of injury to the spine and back have been followed, but intentionally left out of the tables. According to Vogel,<sup>81</sup> Warren,<sup>82</sup> Ebstein<sup>83</sup> and others, transitory glycosuria, but more often permanent diabetes, may follow such injuries, and is considered by most of the above observers to be due to concussion of the spine. Of such cases seen in the hospital during the thirteen months, none presented sugar in the urine, although carefully sought for.

## EXAMINATION OF THE URINE.

The greatest care has been used in the examination of the urine of all cases, and in each especial reference made to the test for sugar.

Fehling's solution was used for both the qualitative and quantitative tests. The routine qualitative tests were made as follows: Taking about three to five cubic centimetres of a freshly prepared Fehling's solution, boiling, and then adding five to fifteen drops of the urine, from which the albumin (if more than a very slight trace) had been previously removed. The solution was *not* boiled after the addition of the urine, but immediately set aside and carefully watched for a reduction. If no reduction of the copper appeared within an hour or two, it was set aside for twenty-four hours and again examined for a deposit of the suboxide of copper. The amounts of sugar which have been designated as a trace and a very slight trace, appeared only after twenty-four hours, and in every instance a distinct precipitate of the suboxide of copper was found. No effort to quantitate slight traces of sugar was undertaken, for such would have been use-

less. In every case, however, where the amount of sugar was sufficient, a quantitative test was made.

In most of the sugar cases the fermentation test was made, not as a means of quantitation, but to detect the presence of glucose; and in all cases in which it was used it proved confirmatory.

Albumin, together with casts and abnormal blood, was found in every case containing sugar, probably secondary, in most instances, to the renal irritation produced by the sugar, even though it had been eliminated only a short time.

Since acetone and diacetic acid are a frequent accompaniment of sugar in the urine, especially in the permanent forms of diabetes, it is of interest to note that they were not found in any of the sugar cases here recorded.

Ebstein<sup>33</sup> reports a case in whose urine acetone and diacetic acid were found, not until eight years after an injury, resulting in a permanent diabetes. As far as found, there is no literature bearing on this subject in those cases where sugar follows a head injury immediately or in a few days. It would appear, then — in cases J. M., Case 112, Class 2; M. R., Case 119, Class 2; and M. K., Case 180, Class 4, where there is some question as to a permanent pre-existing diabetes — that a point in favor of a permanent glycosuria following the injury is the absence of acetone and diacetic acid.

#### AGE AND SEX.

The ages of the cases, where sugar was found, varies between four and a half and fifty-four years, and are quite evenly distributed between these limits. It is therefore concluded from such cases as here observed, that the age has no practical significance.

As regards the sex, very little of value can be

drawn. Although 85 per cent. of the cases having sugar were males, yet it appears to be relative much more, to the liability to injury (as among manual laborers) than to the sex alone.

#### DIET.

From the fact that the diet is oftentimes an important factor in the appearance and disappearance of sugar in the urine, it might be well to state, in a few words, that it had little or no attention in those cases where sugar was found. Following the injury, the patient had milk in sufficient quantities, until the general condition warranted a more generous and substantial diet of meat, vegetables, etc. It is therefore obvious that this question has practically no weight in the sugar cases considered.

#### CONCLUSIONS.

(1) That, after injury, sugar may appear in the urine as early as six hours, and disappear within twenty-four, the average time for its appearance, however, being from eight to twelve hours; for the disappearance of the same, from the fifth to the ninth day.

(2) That a small proportion of the cases may exhibit a permanent glycosuria from the date of injury to the head.

(3) That acetone and diacetic acid are rarely if ever found in such cases, excepting where the condition becomes a permanent glycosuria, and even then probably only after a number of months or years.

(4) That of the twenty sugar cases here recorded, eleven (55 per cent.) had received an injury to the right side of the head; five (25 per cent.) to the left side; three (15 per cent.) to the occiput, and two (10 per cent.) where there was no external evidences of violence.

(5) That it is impossible in the present state of the knowledge of the pathology of diabetes and glycosuria to draw any inferences from the autopsies which have been obtained. It was thought best, however, to report them in full.

(6) That there is little to be said in regard to the mortality. Of the twenty cases, eight died — six being the direct result of severe injuries, one from intercurrent disease, and the third probably from alcoholism. In the 212 cases, 16 were fatal, 50 per cent. of these having glycosuria.

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