

by degrees healed, the child regaining strength slowly, and a little before puberty the cicatrix was perfect. Puberty came on, after which her constitution was very much improved, and she became robust and muscular, but she was affected with a slight lameness. As to the pes equinus, before remarked, I could not ascertain whether it was congenital or otherwise; I assume, however, that it was congenital.

In conclusion, I would beg to remark that I do not for an instant attempt to assert that the view I feel inclined to take concerning the origin of this form of abnormal pelvis is the correct one. I claim merely to have added another to the existing collection of cases of Naegele's deformity of the pelvis, and, perhaps, to have brought forward some facts which may tend to elucidate that abstruse question as to their origin; however, I must say, that the circumstances connected with this present case certainly lead to the conclusion, that an injury was originally inflicted on the right sacro-iliac synchondrosis, followed by inflammation, ending in suppuration, then destruction of the intervertebral cartilage by ulceration, and of a portion of the sacrum by caries; that there was subsequent subsidence of diseased action, followed by the reparative process, producing ankylosis and hypertrophy of bony deposit; but that this did not commence before nearly the whole of the right half of the sacrum had been absorbed; and that physical and mechanical causes coming into play during the progress of these actions, there occurred a flattening of the wall of the pelvis corresponding to the deficient side of the sacrum, together with all the peculiarities of the "pelvis obliquè ovata."

ART. VIII.—*Experiments as to the Existence of Sugar in the Urine of the Fœtus.* By WILLIAM D. MOORE, A. B., M. B. T. C. D.

THE urine of the fœtus has seldom been made the subject of chemical investigation, and yet it is likely that an accurate knowledge of its normal composition would be found to have important bearings in the study of the physiology of man. It is, doubtless, owing to the difficulty of obtaining a supply of this secretion that it has so rarely attracted the attention of chemists; it being, in fact, only in connexion with such an institution as our great Lying-in Hospital, where a large number of children are yearly born, that such researches could be carried out; and it is to the kindness of the present Master of the Hospital, Dr. McClinton, and to the great trouble he has

taken, that I am now indebted for the opportunity of examining a few specimens of the fluid in question.

The difficulty alluded to is due not merely to the fact that the number of children who perish during the process of parturition is comparatively small,—it is much increased by the circumstance that in a large proportion of these the bladder is found empty; and it is curious that, as Dr. McClinton has informed me, this is almost invariably the case in female fœtuses, as if in them the compression experienced in the act of birth had the effect of evacuating the urine, while in the male a greater amount of resistance is, by the formation of the parts, opposed to its expulsion.

“In the works of systematic writers on physiology,” observes Dr. Lee^a, “there is little or no positive information contained respecting the functions of the kidneys previous to birth. Haller, Blumenbach, Meckel, Bostock, and Mayo, have scarcely alluded to the subject, and Magendie states that the condition of the fœtal kidneys has not been ascertained. All the glands employed in digestion have a considerable volume in the fœtus, and seem to possess some activity. The action of the others, he adds, is little known. It is not known, for example, whether the kidneys form urine, or whether this fluid passes by the urethra into the cavity of the amnion. Abernethy was of opinion that the kidneys did not secrete urine till after birth, though some of the older writers believed the liquor amnii to be chiefly formed of the urine of the child.”

Dr. McClinton, who some years ago directed his attention to this subject^b, was able to discover only two instances in which any analysis of the fœtal urine had been made, and, singularly enough, there is the greatest discrepancy between the two reports: Dr. Prout, who examined a specimen for Mr. Hay, found it to be an albuminous fluid, with a very slightly acid reaction, specific gravity 1.012, and depositing on cooling after separation from the albumen coagulated by heat, a considerable quantity of lithic [uric] acid crystals^c; and observed that the residuum obtained by evaporating the urine to dryness contained so little urea that its alcoholic solution gave at first only faint and somewhat doubtful traces of that principle, which, on its standing several days, became, he adds, very distinct; while Mr. Brande, on the other hand, who analyzed the urine of a male fœtus for Sir Benjamin Brodie,

^a Medico-Chirurgical Transactions, vol. xix. p. 238.

^b See vol. vii. p. 46, of the present Series of this Journal.

^c Medico-Chirurgical Transactions, vol. xix. p. 240.

“found it to have the other properties of urine, but to have no uric acid in its composition”^a.

Among later writers, Berzelius, in his *Animal Chemistry*, Simon, in his *Chemistry of Man*, and Lehmann, in his *Physiological Chemistry*, do not allude to the urine of the human foetus.

I have lately seen it stated in a French journal that this fluid contains hippuric acid and ammonia; but as no details were given, nor any authority quoted, I did not make a note of the reference, and am at present unable to refer to the statement.

In the year 1838, I examined a fluid found in large quantity (about six ounces) distending the bladder, ureters, and kidneys of a foetus which died immediately after birth, and in which the urethra was imperforate. Its specific gravity was 1.003; it contained some blood and a considerable quantity of albumen; had, when concentrated, a slightly alkaline reaction; appeared to contain some of the usual salts of the urine; no urea could, however, be discovered.

Ten years subsequently I examined, at Dr. M'Clintock's request, eight specimens of foetal urine, with which he furnished me at different periods. The results of my experiments were given by him in a Paper published in the seventh volume of the present Series of this Journal. I may briefly state that I was able to ascertain the specific gravity in one case only, in which it was 1.0085. Of the specimens, two were acid and one neutral; one or two contained blood, in consequence of the mode in which they were obtained from the bladder; in others this admixture was avoided; but all were albuminous, most of them being highly so. In none could any urea be discovered. The large amount of pavement epithelium they deposited was very remarkable.

In the *Nederlandsch Lancet* for April, 1854, a case is reported by Dr. L. Lehmann, of “Premature Birth; Retention of Urine in the Foetus from Imperforation of the Orifice of the Bladder; Degeneration of the Kidneys with formation of Cysts;” where the bladder is stated to have contained “five or six ounces of clear urine of neutral reaction, in which no trace of albumen could be discovered, while there were epithelial cells in all possible forms and degrees of development; epithelium cylinders of from 0.056 to 0.280, of a millimetre in breadth; bundles of fibrous tissue derived from the kidneys;

^a A Practical Treatise on the most important Complaints that affect the Secretion and Excretion of the Urine, p. 376. By John Howship. London: 1823.

numerous dark-coloured irregular molecules, consisting of urates. The ureters were distended, their walls were thickened, and their course was tortuous; the left, moreover, was divided by partitions into numerous distinct cavities filled with urine. The urine contained in the very narrow calyces and pelvis of the kidneys was also rich in epithelial cells, broad tubuli, and dark-coloured sand. The kidneys were large and flat, loosely connected with the capsule, and on section appeared as a fibrous net work, with attenuated cortical substance filled with a clear fluid; only in the left did any traces of the pyramids still remain. The fluid found, not only between the meshes of the network, but also in the cysts, which were easily isolated, was albuminous, and under the microscope exhibited granular cells, among which were many distinct granules with broken up cellular membrane, transparent, delicate, so-called albumen cells with slender walls, tubuli strongly distended to the breadth of from 0·112 to 0·232 of a millimetre, many of which, obstructed by uric acid, exhibited the same albumen cells in their walls. A dark-coloured granular mass everywhere pervaded the substance of the kidney. The walls, which in some of the isolated cysts were devoid of structure, in others consisted of concentric fibres, and in the larger ones these were particularly distinct"^a.

It appears strange that the urine contained in the bladder should be free from albumen, while the fluid distending the network and cysts, into which the kidneys had degenerated, was albuminous, and, as it is subsequently stated, was rich in that principle.

I have lately seen it mentioned that the foetal urine is normally saccharine, but have not succeeded in ascertaining where the original statement is to be found. It would appear, however, from the following passage in reference to Reynoso's theory of the causal connexion between lesions of respiration and mellituria, that M. Bernard is its author.

"Bernard's discovery that the foetal urine contains sugar is strongly in favour of this view; it is well known that the foetal liver forms sugar, and as the foetus does not respire, its process of oxidation is indirect and feeble; an equivalent amount of sugar accordingly appears unconsumed in the urine"^b. It should be observed, that in a subsequent number of the highly estimated journal from which this extract is

^a Medical Times and Gazette for June 2, 1855, p. 548.

^b Heller's Archiv für Physiologische und Pathologische Chemie und Mikroskopie, for 1852, p. 74.

taken, it is stated that decided distrust is already loudly expressed in reference to Reynoso's conclusions^a.

Thinking it strange that a fluid which I had myself ascertained to contain a considerable quantity of albumen, as well as salts of sulphuric and phosphoric acids and chlorine, and the specific gravity of which still appeared to be extremely low, should, in addition, contain sugar, I became anxious to investigate the point; and appealed to the kindness of my friend Dr. M'Clintock, who has since supplied me with four specimens of the secretion in question.

I regret that the number of specimens I have been able to procure has, for the reasons I have already given, been so small, and I am aware that inferences founded on so narrow a basis must be received with caution; but my object is rather to direct the attention of those whose opportunities may enable them to pursue it, to the examination of a fluid which, in my opinion, presents many points of interest, than to seek to establish what would appear to be the results of my own experiments.

The small quantity in which the fluid is usually found, varying in the majority of cases from half a drachm to two or at most three fluid drachms, is another circumstance which throws difficulty in the way of this inquiry, as it prevents the chemist from performing an extensive series of experiments upon the same specimen of urine; and this is an additional reason why it is desirable that the investigation should be carried on simultaneously by many observers in different places.

The following was the mode of obtaining the urine for the experiments I am about to describe. The urachus and urethra having been tied, the bladder was removed entire from the body, and, having been carefully washed, was opened by a small incision made in the most dependent part, the contents as they escaped being received in a clean vessel.

On the 30th of May, 1855, I received from Dr. M'Clintock a foetal bladder containing about two drachms of clear urine; the reaction of the latter was slightly alkaline; when boiled the fluid deposited earthy phosphates, and was evidently albuminous, continuing opaque after the deposited phosphate was redissolved by the addition of dilute acid; the urine when boiled with liquor potassæ gave no evidence of containing sugar, nor did any reaction indicative of the presence of the latter take place when the urine was highly concentrated previously to the experiment. When freed from albumen, highly concentrated,

^a Page 398.

and treated with nitric acid, it exhibited no sign of the presence of urea.

On the following day I received a specimen of fœtal urine which I found to be very faintly acid; boiled and treated with dilute nitric acid, it yielded flakes of coagulated albumen; it exhibited no trace of either sugar or urea. The deposit was, on microscopic examination, seen to contain a large quantity of epithelium; no blood corpuscles could be detected.

I now determined to examine any specimen I might subsequently procure by means of the modification of the copper test proposed by Dr. Kletzinsky, the extreme delicacy of which I had ascertained by direct experiment. I, therefore, prepared some of the fluid recommended by him according to the form given by Dr. Dahl in his "*Communications from the Chemico-Pathological Laboratory in Vienna*," which I had a short time before translated and published under the title of "*Heller's Pathological Chemistry of the Urine*." The test fluid is prepared by triturating together four parts of a saturated solution of sulphate of copper, six of glycerin, and eight of fused potash. Sulphate of potash crystallizes, and is separated by filtration; the filtered fluid is of a syrupy consistence, and of a beautiful deep blue colour. On boiling a few drops of it with a solution of one part of honey in one thousand parts of water, the copper is quickly reduced, and a similar reaction would evidently take place in a solution even still more dilute.

I also satisfied myself of the delicacy and accuracy of this test in the following manner: having boiled some drops of it for a few minutes with a portion of urine known to be free from sugar, without any change having taken place, I stirred the mixture with a glass rod merely moistened with diabetic urine of the specific gravity 1.034, on which the characteristic changes were instantly produced.

On the 18th of June I received a small portion of fœtal urine having a very faintly acid reaction, and containing a minute proportion of albumen. Boiled with potassa fusa it gave no indication of the presence of sugar, nor did any characteristic change take place on the application of Kletzinsky's test.

The next specimen, which I received on the 16th of July, was tested solely by Kletzinsky's process. It was free from sugar, was slightly acid, and highly albuminous. Under the microscope it exhibited an enormous quantity of nucleated pavement epithelium. Some of the most beautiful specimens of this form of epithelium I have ever seen were deposited from fœtal urine. Some blood and mucous corpuscles, and a few

oil globules, were also visible. The quantity of albumen present, which on ebullition separated in large flakes, was much too great to be derived solely from the small amount of blood contained in the urine. The urine, when freed from albumen, highly concentrated and treated with nitric acid, afforded no evidence of the presence of urea, but when examined after the mode proposed by Dr. E. W. Davy^a, namely, by admixture with hypochlorite of soda, half a cubic inch of nitrogen gas was obtained from two scruples by measure of the urine; this is in the proportion of six cubic inches from the fluid ounce, which, if the nitrogen were derived solely from urea, would represent 3·873 grains of the latter principle. Had such an amount of urea, however, existed, I could not have failed in my attempt to form crystals of the nitrate from the specimen; and although Dr. Prout obtained a considerable quantity of uric acid crystals from a portion of foetal urine, and Dr. L. Lehmann observed urates in that examined by him, the proportion of nitrogen above mentioned is far too great to have been derived from this source; it is, I think, much more likely that it proceeds from the decomposition of a peculiar nitrogenous principle, probably allantoin, present in the urine of the foetus. Analogy would favour this view. Urea, which is more abundant in the urine of cattle than in that of man, has not as yet been discovered in the fluid of the allantoids^b. "The secretion of the non-respiring foetus of the cow is," observes Liebig^c, "in a certain sense identical with the products secreted by the kidneys of the breathing animals. Urea represents carbonate of ammonia from which the elements of two atoms of water have separated; allantoin represents oxalate of ammonia, from which the elements of three atoms of water have separated." Should the correctness of the supposition I have advanced be confirmed by further experiment, it would, moreover, explain the discrepancy between the results obtained by Dr. Prout and Mr. Brande, for, as the composition of three atoms of allantoin is equivalent to that of one atom of uric acid, with one atom of urea and one of water^d, it is easy to conceive that crystals of uric acid might, under certain circumstances, spontaneously separate, while in another case the elements of the allantoin might retain their primitive arrangement.

Allantoin is sparingly soluble in alcohol; I therefore think it probable that the appearances which led Dr. Prout to state

^a London, Edinburgh, and Dublin Philosophical Magazine for June, 1854.

^b Simon's Animal Chemistry; Sydenham Society's Edition, vol. ii. p. 363.

^c Ibid. vol. i. p. 57.

^d Ibid.

that the alcoholic solution of fœtal urine "gave, at first, faint and somewhat doubtful traces of urea," which, "on standing several days, became very distinct," may have been due to the presence, not of urea, but of allantoin; indeed, immediately before, he states that alcohol "was found to take up a principle strongly acid, and which readily assumed an imperfect crystallized form. I cannot venture," he adds, "to give this principle a name; it somewhat resembled the acid called amniotic, or rather allantoid, in some of its properties, but differed from it in others"^a. Or it is possible that urea may have gradually separated from the alcoholic solution of allantoin, if such it was.

I have already stated, that the amount of nitrogen I obtained by Dr. Davy's very ingenious method would represent 3·873 grains of urea in the fluid ounce; now, as 79 parts of allantoin and 60 of urea contain an equal quantity (28 parts) of nitrogen, it follows that the six cubic inches of nitrogen would represent 5·099 grains of allantoin as the amount of that principle contained in one fluid ounce of the fœtal urine under examination, for,

$$60 : 3\cdot873 :: 79 : 5\cdot099.$$

In conclusion, so far as the experiments I have performed go, and I must repeat that the subject has as yet been most imperfectly dealt with, the fœtal urine would appear to be an albuminous fluid of feeble reaction, *free from sugar*, containing some of the usual salts of the urine, abounding in an highly nitrogenized principle, probably allantoin, but affording no urea, and depositing a most remarkably large amount of nucleated basement epithelium.

^a Medico-Chirurgical Transactions, vol. xix. p. 240.