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Original Articles.

SUPPRESSION OF URINE.

WITH REPORT OF A CASE ENDURING EIGHT DAYS; RELIEVED BY DECAPSULATION OF THE KIDNEYS.*

HORACE J. WHITACRE, M.D.
CINCINNATI.

The subject of suppression of urine has been forcibly called to the mind of the writer by a rather unusual case which it is believed may serve as a just basis for the discussion of this topic. This case will first be reported in detail, then certain general considerations will be presented.

THE CASE REPORTED.

Mrs. L., aged 40, slight in figure. The family history is negative as regards transmissible disease. The personal history is that of an individual who has enjoyed unusually good health, who was married at 19 and has born 5 children, 2 of whom are dead. The living children are 11 years, 9 years and 17 months of age, and are in good health. She has had two miscarriages, one four years ago, the other six months ago. She has always done her own housework, leads an active and practical life, and has impressed the writer with the fact that she possesses more than the usual amount of good common sense. She gives no history of previous disease of the kidneys.

About the middle of February, 1903, she found herself to be about six weeks pregnant and under stress of household worries was led to adopt measures which would relieve her of this added responsibility. She took a medicine, the principal ingredient of which was ergot, in uncertain quantities for several days without definite result, then inserted a catheter into the womb. A considerable amount of bleeding followed and continued for several days. On Wednesday, February 25, she became very feverish and sent for her family physician, Dr. Frank Perry of Norwood, Ohio. Dr. Perry found the patient in a decidedly anemic condition, with a pulse of 110 and temperature of 104 F. There was a bloody discharge from the vagina. She said that she had discharged a fleshy mass which she considered to be the fetus and afterbirth. Dr. Perry gave her a thorough vaginal, then an intra-uterine douche of hot lysol solution, one teaspoonful to two quarts of water and prescribed quinin in 5-grain doses every three hours per mouth.

On the following day, Thursday, February 26, her temperature was 100 F. and her general condition satisfactory. She complained of some pain in urination, however, and at about noon passed 8 ounces of urine, which was very thick and highly colored.

On Friday, February 27, the general condition continued to be satisfactory, but she had passed no urine since the preceding day at noon. She was catheterized, but no urine was found. The catheter was pinched and withdrawn and found to contain ten drops of brick-colored fluid, which was considered to be

bloody urine. The bladder was irrigated and infusions of digitalis, large amounts of water and fluid diet were prescribed.

On February 28 no urine could be obtained by catheter, but she stated that a few drops had passed. Acetate of potash and saline purgatives were added to the medication. The writer was asked to see the patient in consultation on this date. The temperature, pulse and respiration were normal, the patient was very cheerful, and stated that she did not feel sick at all. The pupils were normal in size and reaction to light and there was no disturbance of vision. Feeling that she needed careful nursing and hot air baths her removal to Christ's Hospital was advised. This advice was followed and she was admitted to this hospital at 7:40 p. m., with a temperature of 98.8, pulse 88, respiration 20. She was catheterized again, but no urine was found. At 9 p. m. she received an intravenous injection of 60 ounces of normal salt solution. The condition was believed to be the result of circulatory disturbance in the kidney, and it was hoped that the intravenous injection of salt solution would equalize the blood distribution and stimulate vasomotor co-ordination. At 10 p. m. she had a moderately severe chill, with a temperature of 101.6 F. After which she was given hot drinks in abundance and perspired very freely.

THIRD DAY OF SUPPRESSION.

March 1.—At 1:30 a. m. she passed one-half ounce of urine. At 3 a. m., six hours after the first, she received a second intravenous injection of 60 ounces of normal salt solution. During this day her temperature, pulse and respiration remained practically normal. She was given infusion of digitalis as a diuretic and vasomotor tonic. She was purged freely with Epsom salts, 24 watery stools being recorded. She received two hot-air baths. The loins were cupped for 15 minutes. Sixty ounces of salt solution were injected into the veins at 10 a. m., and again at 8 p. m. The most trustworthy of our nurses were assigned to the patient and instructed to make absolutely certain that no urine was passed without our knowledge. The patient was, therefore, catheterized before each stool and pads placed under her for the detection of any urine that might be passed surreptitiously; 40 minims were obtained at one time, 15 at another, and two or three at still other times. The sum total of urine passed during her first 24 hours in the hospital was about five drams. This urine contained a heavy percentage of albumin, no casts, white blood and round epithelial cells and a few red blood cells. The urea percentage was 1.4, as estimated by the Doremus apparatus.

FOURTH DAY OF SUPPRESSION.

March 2.—Patient's temperature varied from 98.6 to 99.8 F., the pulse remained at 70, and respirations at 20. She continued to feel well except for the weakness consequent to such vigorous purging and such continued disturbance. It will appear from the record that the patient was very much disturbed during her first twenty-four hours in the hospital, but she was given, in so far as was possible, the extreme care from muscular exertion and irritation that is accorded the patient who suffers from severe surgical shock. On this date, March 2, she was perfectly composed and had no aches nor pains. Diuretin was now substituted for infusion of digitalis and calomel in one-fourth grain doses given first every hour, then

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continued as a three-hourly medication. On this day she was taken to the operating room and her uterus emptied by curettage of a large amount of decomposing placental tissue. This was done without an anesthetic. The interior of the bladder was at the same time cursorily examined with a cystoscope and found to be both normal in appearance and empty. During this day the bowels moved seven times, and the stool contained blood. The patient vomited a great deal and did not retain much nourishment. The diuretin seemed to be the cause of the gastric irritation, and was discontinued after 12 hours' trial. The total amount of urine obtained by the many catheterizations did not exceed thirty drops. The hot-air baths were continued, but no more salt solution was injected into the veins. It was considered that in the absence of results from the injection of 8 quarts in 24 hours nothing could be expected from further repetitions of the dose. The patient slept fairly well.

FIFTH DAY OF SUPPRESSION.

March 3.—Temperature remained below 99.6 F., pulse 74 to 80, respiration 20. Calomel was continued in one-fourth grain doses every three hours. The bowels moved 7 times. Steam baths, for 25 minutes, were continued. Patient continues to vomit. A sum total of ten drops of urine was obtained by catheterization during the 24 hours. The stool of the patient was examined for urea and found to contain 0.6 per cent.

SIXTH DAY OF SUPPRESSION.

March 4.—Temperature 98.2 to 98.8 F., pulse 70 to 84, respiration 20. Patient slept a great deal. Bowels did not move so freely. An attempt was made to place patient in cabinet bath, but she was too weak to sit up and the steam baths were therefore continued. The patient felt well while in bed. She complained of no headache, no ocular symptoms; in fact, no pains in any region. The calomel was continued. Ten drops of urine are recorded for this period of 24 hours. The character of this urine remained the same. The stool of the patient was again examined for urea and found to contain 0.7 per cent. The uterus was irrigated because of a continuance of a discharge from the external os. On this date patient was taken to operating room, and a second examination of bladder made. The bladder was normal in color, not inflamed and empty. No water could be seen to issue from the ureters and certainly none collected in the bladder during the half hour that the examination was continued with the bladder distended by air. There was no evidence of a calculus in the orifice of either ureter and no bulging at this site. On the contrary, the right ureter was widely open. During each day of the disease the kidneys were both thoroughly and satisfactorily palpated with a view to detecting a developing hydronephrosis from simultaneous obstruction of the ureters by calculi. The kidneys could be felt to be somewhat enlarged from the start, but there seemed to be no progressive increase in their size.

SEVENTH DAY OF SUPPRESSION.

March 5.—Temperature remained 98.6 F., pulse 72 to 90, respiration 20. General condition shows marked failure in strength. The patient slept most of the time and was aroused with difficulty. Citrate of magnesia was given; strontium bromid was given in 10-grain doses every four hours as a diuretic. Calomel was continued. Bowels moved eleven times. Urine was obtained four times by catheter; on two occasions one dram was obtained, on another one-half dram, on another four drops. This urine was examined carefully. The reaction was acid, color amber and cloudy, albumin was present in considerable amount, sugar was absent. The urea percentage was 1.4. On microscopic examination no casts were found, but three varieties of cells were present—white blood cells, bladder epithelial cells and round kidney cells. The white blood and the bladder epithelial cells presented the usual appearance, but the kidney cells presented a most striking example of fatty degeneration. This condition of the kidney cells had been noted in the urine of the preceding days, but to so slight a degree that it was not given much thought. The four specimens obtained at different times on this seventh day of the suppression

demonstrated a very rapidly-increasing number of these fatty cells until the evening specimens presented a most striking picture.

The rapidly increasing numbers of degenerated kidney cells were considered to indicate that the kidney parenchyma was undergoing rapid degenerative changes by reason of the prolonged stasis of blood in its vessels. It was taken as an index of the pathologic changes taking place in the kidney and as a finger-board pointing out the correct line of treatment.

The condition of this patient had been explained from the start, in the writer's mind, on a basis of vasomotor disturbance whereby a stasis of blood, probably under great tension, had occurred in both kidneys. Blood was not flowing through the glomeruli, therefore the secretion of urine was in abeyance. The medication employed was directed to a re-establishment of this circulation and to an elimination of as much urea as possible by way of the skin, bowels and lungs. A continuance of this medication and general line of treatment was believed to be justifiable so long as the condition of the patient remained fairly good. Nevertheless, the operating-room force was held in readiness during this entire time for such operative treatment as might be demanded.

The definite evidence of rapid degenerative changes in the parenchyma of the kidney seemed to the writer to present a positive indication for such operative intervention and the patient was accordingly prepared for this treatment.

On March 6, and at the completion of her eighth day of suppression, the patient was taken to the operating room. Chloroform was used as the anesthetic. The right kidney was exposed by an oblique incision in the loin through all structures (the possibility of extension of the incision for the exploration of the ureters made a muscle-splitting operation undesirable). This kidney was certainly one-half larger, if not double the size of a normal kidney. Its external surface presented a mottled, purplish-blue appearance which at once suggested the appearance of the face of a baby whose head had just been born with the cord compressed. The kidney was lifted from its bed and the body of the kidney, the pelvis and the ureter thoroughly palpated. Nothing abnormal could be found and the pelvis certainly was not dilated. A hollow needle was thrust into the pelvis through the cortex for the double purpose of probing for stone and drawing off urine from a dilated pelvis. This investigation gave negative results.

The opinion already expressed regarding blood stasis seemed confirmed and the capsule of the kidney was split from end to end and totally removed. When an incision was made in the capsule its edges retracted and the cortex bulged through the incision as if under great tension, this in a manner entirely analogous to that seen in brain operations when the dura is opened. Very free hemorrhage followed the separation of the capsule from the kidney, but this membrane was nowhere firmly attached to the cortex by fibrous wedges projected inward. The capsule was of about normal thickness and was stripped off easily. The kidney parenchyma was of a yellowish-gray appearance after the blood-letting of decapsulation and was so brittle that the slightest touch of an instrument seemed to lacerate it. At one time my assistant changed the position of a very blunt abdominal retractor, and in so doing struck the convexity of the kidney. A lacerated wound three-fourths of an inch long and one-half inch deep resulted. The naked eye appearance of the cortex was that of marked fatty degeneration. The capsule of the kidney was entirely excised, the kidney dropped back into its bed, gauze drainage was inserted and the external wound closed. A provisional stitch was inserted for the purpose of completing the primary closure of the wound after the removal of the drainage 24 hours later.

Exactly the same procedure was immediately applied to the left kidney. This organ presented precisely the same anatomic conditions; the pelvis was likewise found to be free and the capsule was removed. The time consumed in the double operation was 45 minutes. The patient stood the operation perfectly well, her pulse did not exceed 100, and she was put to bed in a most satisfactory condition. At the time of her return to bed the pulse was 70 and the respirations 20 per minute. There was no vomiting from the anesthetic.

One hour after operation the patient expressed a desire to urinate and two ounces of intensely bloody urine were obtained by catheter. This urine was neutral in reaction, albumin was abundant in a filtered and centrifuged specimen and the urea percentage was 1.4. Microscopically red blood cells were present in large numbers; the same round cells presenting in advanced stage of fatty degeneration were found in abundance, but no casts.

The temperature remained normal throughout the remainder of the day, the pulse varied from 72 to 80, the respirations from 24 to 28.

At 6 p. m. (six hours after operation) $2\frac{1}{4}$ ounces of urine possessing the same naked eye, chemical and microscopic characteristics were voided by the patient.

At 9 p. m. $1\frac{3}{4}$ ounces of urine of similar nature were voided.

The patient was given water per mouth in six hours after operation.

At 1:30 a. m. 2 ounces and at 5:30 a. m. $4\frac{1}{4}$ ounces were passed. Three ounces at 8:30 a. m., and 4 ounces at 11:40 a. m., gave a sum total of 21 ounces of urine passed in the first twenty-four hours after operation.

The urine continued to be intensely bloody, the reaction became acid at 1:30 a. m., the specific gravity was 1,009, and the urea percentage had diminished to 1 in the morning urine. The fatty cells persisted to the end of the twenty-four hours. An 8-ounce bottle containing the first urine passed showed a red deposit $\frac{1}{4}$ inch thick after settling for a few hours. The patient was rather drowsy during the day, had some abdominal pain, and vomited once.

The second twenty-four hours after operation, the temperature, respiration and pulse remained normal. The urine was passed in from 3 to 10-ounce quantities and aggregated 48 ounces. The blood rapidly disappeared and the urine became amber color by the end of this period. The reaction continued to be acid. The specific gravity did not vary from 1,008. The urea percentage varied from .85 to 1.5. Albumin was present. Red blood cells were always present microscopically. The fatty cells had disappeared by the end of the period. No casts were found in any specimen.

The patient rested well, took liquid food with much indifference, and vomited bile once or twice. She was delirious for two hours during the night, but slept well with this exception. The gauze drainage was removed and the provisional sutures tied.

The third twenty-four hours after operation, temperature, respiration and pulse remained normal. The amount of urine aggregated 89 ounces. The character was about the same as that during the second 24 hours except that it became bloody again for about six hours, then returned to amber. The patient rested well. The diet consisted of toast, egg, cocoa, oyster broth, ice cream, and orange albumin water. There was great prostration, but patient was cheerful. The bowels moved well.

The fourth twenty-four hours, temperature, respiration and pulse normal. Total amount of urine 56 ounces. Urine clear; very few red cells; no casts; trace of albumin; specific gravity 1,009; reaction acid; no sugar.

The fifth twenty-four hours, temperature, respiration and pulse normal. Total amount of urine 77 ounces. General condition good. Quality of urine the same as during the fourth day. Appetite vacillating. Some delirium at night, yet patient slept well. Patient received eggnog and strychnin sulphate grs. 1/60 as continuous tonic stimulation.

The sixth twenty-four hours, temperature and respiration normal. Pulse became elevated to 100. Total amount of urine 64 ounces. Urine amber color and cloudy; reaction acid;

specific gravity 1,009; trace of albumin; no sugar. Microscopically amorphous urates, a very few red blood cells and no casts were found. Urea percentage 1.4.

The seventh twenty-four hours, temperature 98.4 to 99.2, pulse 90 to 120 and bounding, respiration 20 to 26. Total amount of urine passed 47 ounces. Quality of urine same as on sixth day. Patient felt very weak and looked very pale, but said that she had no pain and felt very well. Appetite failed somewhat.

The eighth twenty-four hours, temperature, respiration and pulse normal. Total urine 52 ounces. Quality same as on sixth day.

The ninth twenty-four hours, temperature 90 to 102, pulse 108 to 120 and bounding. Respiration 24. Total urine 45 ounces. Quality of urine same, except that it is now perfectly clear. No explanation could be found for the rise in temperature and pulse rate. One physician who saw the patient at this time stated that the pulse was that of a patient just previous to puerperal eclampsia and advised the use of a veratrum viride. This was not given, however.

The tenth day, temperature 99 to 101, pulse 80 to 100, respiration 24. Total amount of urine 44 ounces. General strength improved, patient feels better and asked to get up. Quality of urine the same as on sixth day.

During the eleventh day the total amount of urine was 47 ounces; during the twelfth day 52 ounces; during the thirteenth day 48 ounces; during the fourteenth day 78 ounces; during the fifteenth day 62 ounces; during the sixteenth day 65 ounces; during the seventeenth day 47 ounces; during the eighteenth day 64 ounces; during the nineteenth day 80 ounces. On this date the patient returned to her home, and the husband has reported that the total amount of urine has averaged from four to four and one-half pints per day for every day since March 25.

The temperature returned to normal after the tenth day and remained so. The strength of the patient improved steadily, and she sat up on the sixteenth day after operation. The appetite improved rapidly until it became normal. The urine became normal on the seventeenth day.

It is believed that this patient suffered from a vasomotor suppression of urine. There are two factors which may have acted in a causative relationship to the condition. Either the ergot which was contained in the emmenagogue caused a strong and persistent vaso-constriction, or a strong reflex was communicated to the kidney at the time of the destruction of the ovum or by the uterine irrigation. Neither of these could be called an overpowering reflex, and it is certainly true that such a result would be most unusual, yet at the same time we must take into consideration the fact that the susceptibility of the nervous system to irritation and to reflex, particularly in women, is a most variable quantity. The patient was not exposed to conditions which would cause an acute nephritis, nor did she present the slightest symptom of this disease at any time. She was perfectly well up to the time of the destruction of the ovum. The temperature which she presented at the time of Dr. Perry's first visit is not believed to have been the result of septic infection, since it disappeared after one flushing of the uterus, and the material found in the uterus at the time of curettage did not seem to be infected. It is, of course, possible that there was some absorption of decomposition products into the general circulation, yet in the absence of any disturbance of the temperature and pulse rate it is difficult to believe that these products were very poisonous.

GENERAL CONSIDERATIONS.

The writer has been impressed on more than one occasion by the fact that our ready reference text-books of surgery contain little or no mention of the subject of suppression of urine. The condition is given a brief

mention as a symptom, in connection with certain surgical diseases of the kidney and ureter, but is nowhere discussed in full, in so far as he knows, as a definite condition entitled to elaboration from the viewpoints of etiology, diagnosis and treatment. The literature on this subject, even though meager, is valuable and should be collected into such available form as will give a definite classification and a clear exposition of the subject. It has been the unfortunate experience of the writer to encounter this condition in a variety of forms; indeed, every surgeon has his quota of deaths after operation from suppression of urine and every surgeon knows the anxiety that is felt during the hours of its possibility and of its endurance.

It has been stated that suppression of urine is merely a symptom and not a disease. It is certainly true that suppression of urine may be but a single symptom in the picture of a given disease, e. g., cancer of the uterus with involvement of the ureters, but it is likewise true that in the majority of cases which are presented to the surgeon the suppression of urine is the one condition which imperatively demands treatment, and the one condition which is going to kill the patient unless relieved. Furthermore, each case of suppression of urine must be accurately and painstakingly studied from the viewpoints of etiology, pathology, symptoms, diagnosis and treatment, and it requires but slight reflection to see that the investigation and the management of these cases present unusual difficulties.

Such, it seems to the author, are the claims of this subject to a place among surgical conditions.

The present paper does not present for your consideration a solution to the problems of suspended kidney function, nor does it furnish a full presentation of the subject. The case, which is recorded above, is offered as a contribution to the meager literature on this subject, while the appended general discussion is presented in the purely suggestive light of personal impression gained from clinical experience and from some reading.

DEFINITION.

Suppression of urine is commonly defined as a condition in which the excretion of urine from the tubules of the kidney is entirely suspended or in which no urine is transmitted to the bladder. This definition is made to cover two distinct conditions and is believed by the author to be open to criticism. It would seem more accurate to omit the latter clause and say that suppression of urine is a condition in which the excretion of urine from the parenchyma of the kidney is suspended. When one or both ureters are mechanically obstructed the parenchyma of the kidney continues to perform its functions until a quantity of urine varying from a few ounces to one gallon has been secreted and until the pressure has become sufficiently great to arrest secretory pressure. When the urethra is mechanically obstructed the same accumulation of urine occurs behind the obstruction and the same result may follow in the kidney. Yet an accumulation of urine behind an urethral obstruction is called retention of urine, that behind an ureteral obstruction a suppression of urine, and the two are carefully differentiated. To my mind they are in reality one and the same lesion, except for the location in the tract of the obstruction, in the seriousness of the condition and in the accessibility of the lesion. The one may be diagnosticated and relieved by urethral, the other by ureteral examination and catheterization. Furthermore, the correct surgical treatment in each case is directed to the seat of mechanical obstruction with the

one purpose of liberating the pent-up kidney secretions and of preventing or relieving serious secondary lesions in the kidneys.

In suppression of urine, as defined, the secreting mechanism itself is at fault; the lesion is primary in the kidney, and no urine is separated from the blood. The treatment of the condition must be based on entirely different grounds, and the lesion must be studied from the physiologic side.

We have, then, two distinct conditions, the one mechanical and always surgical, the other physiologic and sometimes surgical, and each worthy of careful study from the viewpoint of etiology and pathology. An appropriate division of that condition in which no urine is discharged from the body would seem to be: 1. Vesical and urethral retention or obstruction of urine. 2. Ureteral retention or obstruction of urine. 3. Suppression of urine.

It is believed by the writer that the above modifications in the definition of suppression of urine or anuria should be made. Yet the present discussion of the condition will be pursued according to the usual definition and a division of the subject will be made into an obstructive and non-obstructive form, each of which may be elaborated under the heading of etiology.

ETIOLOGY.

The condition presented to the physician is one of "no urine," and it becomes necessary for him to seek the cause of this condition. The following table is offered as a concise statement of the causes of suppression of urine.

I. OBSTRUCTIVE SUPPRESSION OF URINE may result from:

- A. A calculus, a blood clot or a plug of pus in the ureter. This may cause complete obstruction.
 - (a) In the ureter of the only existing kidney.
 - (b) In a single fused ureter from the two kidneys or from a horseshoe kidney.
 - (c) In the ureter of the only functioning kidney, the other kidney having been previously destroyed by calculous obstruction, tuberculosis, nephrolithiasis, suppuration, tumor, cyst, etc., etc. This is by far the most common form.
 - (d) From the simultaneous obstruction of both ureters (rare).
- B. Stricture of the ureter under the four above-named conditions.
- C. Kink in the ureter of a floating kidney or angular attachment of the ureter to the pelvis under similar conditions.
- D. Tumor of the kidney.
- E. Tumor of the base of the bladder or of other organ involving both ureters.
- F. External pressure.
 - (a) Myomata of the uterus.
 - (b) Cancer of the uterus or rectum.
 - (c) Abdominal tumors.
 - (d) Laceration of the cervix with subsequent involvement of the ureter in the cicatrix.
- G. Venous congestion. An excessive degree of exudate when associated with congestion of the intertubular veins may cause a degree of lateral pressure which may result in suppression. The suppression of urine in the author's case may be explained in this way.

II. NON-OBSTRUCTIVE SUPPRESSION OF URINE may occur as a result of:

- A. *Reflex circulatory or vasomotor disturbance* in the kidney. This may occur—
 - (a) *After operations* which concern in any way the complex sympathetic nervous mechanism of the abdominal cavity, e. g., nephrectomy, nephrotomy, operations on the bladder, operations on the male or female genital tract.
 - (b) *After the passage of a catheter* or a sound into the bladder. This agent may act either as a reflex or as a septic infection.
 - (c) As a result of the *lodgment of a calculus* in one ureter, the other remaining free. The reflex in this case may result either from the nerve irritation at the site of lodgment of the calculus or from the acute tension which occurs within the pelvis of the obstructed kidney.
 - (d) *Trauma*, subcutaneous or direct. In a case related by Dr. Oliver, a bullet merely cut a groove in the convexity of one kidney yet the patient died from suppression of urine.
 - (e) *Hysteria*.
 - (f) *Drug vaso-constriction*, e. g., ergot, auto-nephrotoxins.
 - (g) *Extensive burns*, may act either by a reflex or by sepsis.
 - (h) *Meningitis*. (A case reported by Fussell, in *Pediatrics*, August, 1901.)
- B. *Degenerative changes in the kidney*. These may result from:
 - (a) Poisoning by drugs such as phosphorus, carbolic acid, cantharides, turpentine, etc., possibly by ether and chloroform when used for surgical anesthesia.

- (b) Acute infectious diseases such as septicemia, cholera, scarlet fever, dysentery, etc.
 - (c) Acute nephritis.
 - (d) Auto-nephrotoxins. This is a toxic product, a cytotoxin, which is formed as a result of active disintegration in one kidney and which acts to produce marked degenerative changes in the opposite sound kidney. Castaigne and Rathery suggest that perchance certain renal disturbances now described as the result of reno-renal reflex nervous influences or as sympathetic nephritis are the outcome rather of auto-nephrotoxins.
 - (e) Tubercular or cystic disease of both kidneys may progress to the total destruction of all secreting tissue.
- C. *The direct effect of lessened heart force.* When the aortic pressure sinks below 40 mm. Hg. the urinary secretion stops absolutely. So long as the blood pressure is above this height the secretion is more or less proportional to the pressure, and changes with the changes in this pressure.
- D. *Trauma.*
- (a) Direct paralyzing injury to both kidneys or to one kidney when the other is non-functionating.
 - (b) Rupture of the kidney, the ureters, or the bladder with extravasation into the tissues of all urine secreted. This must be included under the old definition of suppression of urine, but is not believed to belong to the subject at all.
- E. *Anesthesia.* It would be very difficult to classify this etiologic factor more accurately, for the reason that we do not certainly know the exact manner in which these drugs act on the kidney. Kemp concludes that ether, while producing a rise in general arterial pressure, manifests a deleterious and specific influence in a lowered renal pressure and almost immediate diminished secretion, whereas chloroform, when producing a decrease in carotid pressure, exerts but an insignificant effect if any on the renal pressure or excretion. On the other hand, Galiczi and Grillo maintain that the diminution of renal permeability is more marked when chloroform is used than when ether is administered, and they claim that this result renders any infectious disease with which the patient so anesthetized may be affected more severe.

PATHOLOGY.

A complete study of the pathologic lesions mentioned above as etiologic factors would be both impracticable and undesirable in the present paper. The pathology of those conditions enumerated under the heading of obstructive suppression is so well understood and so well described in all text-books of pathology that its recapitulation is considered unnecessary. The same may be said of some of the conditions included under the heading of non-obstructive suppression, yet it is this particular section of the subject which presents the perplexing questions, and hence it is this section which should receive most attention.

In view of the fact that we are dealing with alterations in the functional value of the specific parenchyma of the kidney, it is certainly true that we will find a physiologic basis to be the correct one on which to construct our pathologic and therapeutic superstructure.

PHYSIOLOGIC CONSIDERATIONS.

The kidney is a compound tubular gland in which the vascular apparatus is so arranged as to afford (a) the most favorable conditions for filtration of the liquid parts of the blood, and (b) the most favorable conditions for the elimination of the waste products of body metabolism by its specific excretory cells. The secretion of this gland is complex in its composition, contains most of the end products of the varied metabolism of the tissues and represents the most vital excretory product of the body. This secretion may be looked on as a solution of a great number of organic and inorganic substances in water.

The nerve supply of the kidney is vasomotor (vaso-constrictor and vaso-dilator) and secretory. The vessels of the kidney, like those of all parts of the body, are under the direct control of the central nervous system. The secretory nerves are not fully understood. The nerves are definite off-shoots from and an integral part of the vast abdominal sympathetic system, and are connected with the spinal cord through the anterior roots of the eleventh, twelfth and thirteenth dorsal nerves. These nerves enter the hilum of the kidney both as a plexus closely investing the renal artery and as fibers which run parallel to the vessels and can be traced as far as the cortex.

The secretion of urine consists of two distinct processes: (1) The secretion of water and salts, and (2) the elimination of urea and related bodies. The secretion of the waters and the inorganic salts undoubtedly takes place through the glomerulus. The excretion of urea and related bodies is believed to take place through the agency of the epithelial cells lining the convoluted tubules. These cells perform the function of secreting the specific nitrogenous elements of the urine, which are taken up into solution by the water which flows downward from the glomerulus and a completed urine is formed.

The secretion of water and inorganic salts seems to be largely, yet not entirely, a question of mechanical filtration or separation and to depend mainly on two factors.

(1) The difference of pressure between the blood in the glomerular capillaries and the urine in Bowman's capsule. The pressure in the tubule is practically *nil* under normal circumstances, so that the only changeable factor will be the blood pressure in the capillaries.

(2) The rapidity of the blood flow through the glomeruli. The more frequently the fluid is presented to the filter the more rapidly will the process go on.

The glomerular circulation may be affected in several ways. The pressure in the glomerular capillaries will be raised and the velocity of the blood increased:

(1) By a rise in the general blood pressure. This may be due to (a) increased force and frequency of the heart, (b) constriction of vascular areas in other parts of the body.

(2) By dilatation of the renal arterioles, the general blood pressure remaining constant.

(3) By obstructing the renal vein. In this case the velocity will be diminished.

The pressure and velocity in the glomerular capillaries will be diminished:

(1) By diminished general blood pressure, which may arise from a weakening or slowing of the heart beat, or from dilatation of vascular areas in other parts of the body.

(2) By constriction of the vessels in the kidney itself.

As has been stated above, a diminution of aortic pressure below 40 mm. Hg. results in an absolute cessation of secretion and variations in pressure above this point will be followed by corresponding variations in the amount of urine secreted.

It is to this vasomotor mechanism of the kidney that we must look for the regulation of the flow of blood through the kidney, hence for a rational explanation of variations in the secretion of urine.

Stimulation of the vaso-constrictor fibers causes contraction of the arteries of the kidney, a diminution in the size of the organ and a diminished secretion of urine. Stimulation of the vaso-dilators will have precisely the opposite effect. Both of these sets of fibers are probably brought into play under normal conditions by reflex stimulation, and thus serve to regulate the flow of blood through the kidney and thereby influence its functional activity.

It has been estimated that, in strong diuresis, 5.6 per cent. of the total quantity of blood sent out of the left heart in a minute may pass through the kidneys, although the combined weight of these organs makes only 0.56 per cent. of that of the body.

That the formation of the water of the urine is not entirely a question of filtration, however, would seem to be demonstrated by two experimental facts:

(1) Ligation of the renal vein raises the blood pressure in the glomerular capillaries almost to that of the

renal artery, yet the secretion of urine is promptly arrested.

(2) Ligation of the renal artery causes a complete arrest in the secretion of urine. Removal of this ligature after a few minutes restores at once a normal circulation and pressure of blood in the glomeruli, yet the secretion of urine is not re-established for one hour, and when it does return it contains albumin.

These facts have led Heidenhain to believe that the secretion of water depends on the active intervention of special secretory cells, and that any agent which interferes with the physiologic value of these epithelial cells covering the glomerulus will result in corresponding alterations in the amount and the quality of urine secreted. If such an explanation is correct we will find in this physiologic fact a most valuable aid to the explanation of degenerative suppression of urine. Furthermore, in those forms included under the head of venous congestion the direct causative factor may be a decreased secretory power or a decreased permeability of these cells, which has resulted from an insufficient blood supply.

It must be admitted, however, that physiologists are not yet agreed on all points concerned in the secretion of water, and it seems clear that at present we are not justified in asserting more than that the glomeruli control in some way the production of the water and salts of the secretion. The extent of the activity seems to be correlated with the quantity of blood flowing through the glomeruli.

It is a fact of some importance in the present study to note that the most important of the pathologic constituents of the urine, such as albumin, hemoglobin and sugar, seem to escape from the blood into the tubules through the glomerular epithelium.

The exact nature of the forces involved in the excretion of urea by the actively secreting cells of the convoluted tubules is not entirely understood. The normal stimulus to these cells seems to be the presence of urea and related substances in the blood and the rate of elimination will vary, under normal conditions, (a) with all variations in the percentage of urea in the blood, and (b) with the velocity of the blood flow through the capillaries. The elimination is not a simple act of diffusion, because the percentage of urea in the urine is greater than that in the blood. All that we can say is, that in some way the urea is selected from the blood and quickly transferred to the lumen of the tubule without alteration in chemic composition and without accumulation in the cell.

PATHOLOGIC CONSIDERATIONS.

Reflex Vasomotor Suppression of Urine.—The kidney parenchyma, it will be remembered, is enclosed within a firm unyielding capsule, analogous in every way to the capsule (sclera) of the eye and the bony casement of the brain. Under normal conditions a vaso-constriction diminishes the amount of blood entering this capsule, the kidney capillaries become anemic, and an amount of blood escapes through the veins exactly equal to that which enters. Under normal vaso-dilator action the amount of blood entering the closed sac is exceedingly increased, the entire organ increases in size, the capsule becomes tense, yet again the venous return is entirely efficient and carries off an amount of blood exactly equal to that which enters. The blood circulation through the kidney is perfect in each instance, but the amount of blood flowing through the organ is widely different. The regulation of the exact amount of blood that shall

flow through the kidney, it will be remembered, is the direct result of what may be called normal reflex stimulation.

Now, suppose we have an overpowering stimulation of any part of the abdominal nerve plexus, an overpowering reflex, such, for instance, as will result from a nephrectomy. One of three things may happen in the remaining kidney:

(1) There may be an intense stimulation of the vaso-constrictor nerves which will cause a temporary or persistent cessation of blood flow through the glomerulus.

(2) There may be a sudden paralysis of the vaso-constrictor nerve fibers and an increased flow of blood to the kidney; or there may be

(3) A marked stimulation of the vaso-dilator fibers and again an increase in the flow of blood into the kidney.

Intense Stimulation of the Vaso-constrictors.—This may be expected to cause a temporary or perhaps a somewhat continued arrest of blood flow into the kidney. The secretion of urine will immediately stop. The kidney will become anemic and the blood contained in the organ will flow off through the veins. Now, it has been demonstrated anatomically that the kidney receives a feeble anastomotic circulation through its capsule. Furthermore, it has been demonstrated that simple ligation of the renal artery will cause a condition of red infarct in the kidney, while the ligation of this artery, after the complete removal of the capsule, will result in a condition of white infarct. This means that after ligation of the renal artery blood flows through this anastomotic circulation into the kidney in sufficient quantity to engorge the vessels, yet under insufficient pressure to re-establish the circulation of the blood through the organ. A condition of red infarct results. When the capsule is removed, however, this anastomotic circulation is cut off and all blood left in the kidney drains off, leaving the capillaries empty and the tissues white.

Precisely the same conditions are presented when a sudden vaso-constriction closes the vessels of the kidney. The blood flow is arrested and this same anastomotic circulation engorges the capillaries and veins of the cortex. The endothelial cells in the walls of the capillaries and the small veins have suffered a degenerative change, however, because of the arrest of blood, and they permit the serum to leak out between the tubules. Now, since it is improbable that a complete obliteration of the arterioles by vaso-constriction could endure for a very extended period of time, let us see what would happen when these arterioles begin to open again. Blood is once more pumped into the kidney, but the venous return is seriously impeded by the lateral pressure of the exudate which has formed around and between the paralyzed veins and the tubules. The congestion of the vessels of the kidney becomes more intense with each heart beat, and a condition analogous to experimental ligation of the renal vein ultimately results. The blood flow through the kidney is stagnant, no urine is secreted, the capsule becomes over-distended and tense, the blood becomes highly venous and the kidney parenchyma suffers serious degeneration from insufficient oxygen and food supply. This is precisely the lesion found at the time of operation in the kidneys of the patient whose case has been reported in this paper.

Should the overpowering stimulation of the nervous mechanism of the kidney result in either a paralysis of the vaso-constrictors or a stimulation of the vaso-dilators, the effect on the circulation would be the same and the reasoning as to the ultimate effect on the kidney of both

would be precisely the same as that followed for the explanation of vaso-constriction suppression, except that the anastomotic circulation would probably play no part.

Degenerative Form.—It seems very easy to explain the degenerative form of suppression of urine on physiologic grounds if we give to the glomerular epithelium the pure secretory function that has been suggested. If the glomerular cells secrete the water then the correct performance of this function will be absolutely dependent on the anatomic and physiologic integrity of these cells, and any agent which causes serious degenerative changes in these cells will assuredly exert a corresponding influence on their secretory product. Such conclusions do not seem to be justified, however, by our present physiologic knowledge. At the same time there must be some connection between the normal secretion of the water of the urine and the integrity of the glomerular epithelium, be this a property of secretion or one of permeability, and it is believed that further experimental work in this direction will yield some definite results.

Lessened Heart Force.—The effect of a lessened heart force with a lowered aortic pressure finds its complete explanation in physiologic fact. The suppression of surgical shock will find its correct classification under this heading, and will be most correctly treated by directing the attention to the general circulation.

The pathologic findings in those kidneys examined by the author after death from suppression of urine have uniformly been slight. An intense congestion of all vessels in the cortex and a marked cloudy swelling of the parenchyma cells have always been present. The intertubular area has been uniformly widened and always filled either by capillaries and veins or by a fluid exudate. The most striking feature of the lesion has always been a complete injection of all vessels of the kidney by red blood cells. An exudate within the tubules has not been observed. It has so happened that all of the kidneys examined by the writer showed either no evidence of a chronic nephritis or so slight a change that this lesion could not be considered to be a predisposing cause. As has been stated, the kidneys, exposed in the case that has been reported, showed a most intense degree of venous congestion and a very high degree of tension within the capsule; when this tension was removed and a large amount of venous blood had drained off the cortex looked comparatively pale.

DIAGNOSIS.

The condition presented to the physician for diagnosis is an absence of the usual discharge of urine from the body. The first point that must be decided is the proper classification of the particular case under the heading of either the obstructive or the non-obstructive form of suppression of urine. The determination of this one point will call for the most thorough possible history, both as regards previous illness and the existing attack. This history must deal minutely with all symptoms referable to the functional value of the kidneys, and all preceding attacks of pain in the abdomen, the loin, the back or bladder must be investigated with a view to establishing a probability or a certain diagnosis of pre-existing parenchymatous or calculous disease of one or both kidneys. It is a well-known fact that most cases of total obstruction of urine from blocking of the ureter occur in individuals who have previously suffered a destructive lesion in one kidney. This previous disease in the destroyed kidney may be unknown to the patient, or he may have forgotten the slight symptoms that he suffered.

The physical examination of the patient must be equally thorough and equally complete. The passage of a catheter into the bladder will rule out urethral obstruction. A cystoscopic examination will determine the presence or absence of tumor of the bladder and may detect a calculus in the vesical opening of the ureter. Catheterization of the ureter or the introduction of the wax taper, as suggested by Kelly, will determine the patency of the ureters and may give positive evidence of the presence of stone.

If the ureters are patent we may consider that the diagnosis of a non-obstructive or true suppression of urine is established. It is not always possible to apply methods of precision to this degree, however, and a diagnosis must sometimes be made on the evidence furnished by abdominal palpation and the history of the patient.

The differential diagnosis of the various conditions referred to under the heading of obstructive suppression is not believed to belong to the present study and is well described elsewhere.

A differential diagnosis between those conditions included under the heading of true suppression of urine or non-obstructive suppression will usually be made from the history of the patient alone. It will usually be self-evident that the patient has ingested a poison, that he has suffered a strong reflex, that shock is present, that the heart's action is feeble or that an anesthetic has been given.

TREATMENT.

A discussion of treatment again divides itself naturally in accordance with the general division of the subject into the obstructive and the non-obstructive form.

The Obstructive Form.—The treatment of this form of suppression is always surgical, and is always directed to the re-establishment of efficient excretory channels or ducts. Such methods of treatment are well described in all text-books of operative surgery. Again, it must be stated that this section does not, in the opinion of the author, belong to the subject of suppression of urine.

The Non-obstructive Form.—The first thought that will come to the mind of the majority of practitioners of medicine in the presence of any form of suppression will be, what diuretic will act most promptly?

The mode of action of diuretics is not well understood. Without entering on a discussion of the subject it may be stated that the saline diuretics, such as urea, dextrose, sodium chlorid, potassium nitrate, potassium acetate, etc., produce an increased flow of blood through the kidney, hence an increased flow of urine, by reason of an hydremic plethora which they induce. The result of injecting these substances into the blood has been proven to be an active flow of water from the tissues into the blood. The blood, therefore, becomes diluted to an extent varying with the osmotic pressure of the substances injected. Caffein again seems to produce its diuretic effect by reason of its effect on the renal vessels. The effect of digitalis, in producing diuresis, is more complex, yet it seems probable that its action may be explained by its effect on the general circulation. It slows and strengthens the heart beat and at the same time constricts the smaller arteries of the body, so that the arterial pressure is raised. Therefore, its legitimate use in suppression of urine will be restricted to those cases of heart disease in which a feeble heart action, a lowered arterial and an increased venous pressure are the cause of an imperfect flow of blood through the kidney. Under such conditions digitalis will act as a powerful diuretic.

The Treatment of Vasomotor Suppression of Urine.

—It has been demonstrated that the pathologic lesion in this condition is an intense venous congestion of kidney. The blood is stagnant, the venous return is progressively more and more impaired by lateral pressure, the kidney capsule is tensely overfilled, and blood is being continuously pumped into an already overfull organ. This kidney certainly needs depletion and those measures should be applied which will withdraw blood from it.

Diuretics may act favorably on such a kidney or they may be the very worst possible thing for it. The lesion is uniformly a greatly impeded venous return from the organ or a venous stasis. Now, if by increasing the arterial pressure behind this stagnant blood it can be forced on into the renal vein, then a diuretic will relieve the existing stasis and render conditions favorable to an absorption of any exudate that may be present. Such reasoning is followed in the treatment of pneumonia, and the heart receives more attention from the therapeutic standpoint than the lung itself. If, however, the obstructive lesion in the veins has become so marked that this piling up of pressure from behind can not overcome it, then these same drugs only intensify the lesion by sending more and more blood to the organ.

It seems to the writer, therefore, that the course pursued in the treatment of the reported case was correct. Fresh infusion of digitalis was first given with a view to strengthening the heart, equalizing the circulation and restoring vasomotor tone. This failing it was deemed wise to establish a high degree of hydremic plethora by the most prompt possible means. Sixty ounces of normal salt solution were therefore injected into the veins every six hours for four doses. This measure also failed in this particular case, and in the light of subsequent history both measures probably did her kidneys more harm than good. Nevertheless, it is believed that these measures are correct and that they will serve to re-establish the flow of blood through the kidney, hence the flow of urine, in quite a percentage of very early cases.

Depleting agencies will occupy a position of high importance in the treatment. These measures are applied for two reasons: (1) For the purpose of withdrawing blood from the kidney; (2) for the purpose of removing urea from the blood. To this end cupping of the loins, free purgation and sweating with pilocarpin and hot air are to be strongly recommended. Large hot irrigations of the colon with salt solution may be tried.

OPERATIVE TREATMENT.

Should the above-named measures fail to bring about the desired result with promptness, we must conclude that the venous stasis in the kidney has attained a high degree. The operative treatment of decapsulation should then be applied. This treatment seems to the writer to meet the conditions exactly. The high degree of tension is relieved, the veins are emptied by blood letting and conditions are rendered favorable for both the re-establishment of the circulation and for the absorption of exudate. It is possible, in addition, that the massage of the kidney may in some way exert a favorable influence on its nervous mechanism. Suffice it to say that the prompt and perfect result in the case reported must be taken as definite evidence that decapsulation is a therapeutic agent of great value.

The suppression of urine that occurs in conditions of shock should be considered in the light of a symptom. Absolute quiet, external heat, elevation of the feet, in-

travenous injection of salt solution and strychnin will be found to be the main elements in the treatment.

Degenerative suppression of urine will require a somewhat different reasoning. The element of prime importance in the treatment will be the withdrawal of the poisonous agent. A degenerated cell or a degenerated organ is one in which the nutritional supply, the metabolic process or the process of excretion are at fault. Therefore, every measure should be adopted that will restore to the kidney a large amount of good blood and which will keep this blood in active circulation. Drugs will be of some value and salt solution will serve the double purpose of filling the vessels and of diluting a contained poison.

In conclusion, the statement will be repeated that the above discussion of the condition of suppression of urine is presented in a purely suggestive light, and it is hoped that it may lead to the more thorough investigation of some of the obscure points in etiology, pathology and treatment.

The discussion on the papers of Drs. Whitacre, Guthrie and Ferguson will follow the paper of Dr. Ferguson in a subsequent issue.

CONTRIBUTION TO THE SURGERY OF
GASTRIC ULCER.*

VAN BUREN KNOTT, M.D.

SIOUX CITY, IOWA.

The literature on the surgical treatment of ulcer of the stomach has, during the last few years, grown to vast proportions and the subject has been most ably and thoroughly presented. It is not my intention to attempt a résumé of this literature, nor to take up the subject of gastric ulcer in detail.

There is, however, one of the frequent complications or sequelæ of chronic ulcer of the stomach which my experience indicates will bear still further discussion than it has been generally accorded. I refer to adhesions of the stomach to a neighboring viscus or the abdominal wall, and this paper will be confined to a brief consideration of the symptomatology, diagnosis and treatment of this condition.

Enough has been said and written concerning the surgical treatment of alarming hemorrhage, perforation and dilatation of the stomach resulting from ulceration of the organ, to establish quite firmly good and sufficient rules for guidance as to our management of these dangerous and distressing complications and we find these rules very generally accepted and applied.

The adhesion of the stomach to a neighboring organ or to the abdominal wall may occasion symptoms quite as distressing as those due to pyloric stenosis and in many instances really jeopardize the life of the patient.

It is the purpose of this article to consider only those cases of adhesion the result of gastric ulcer. That the condition may be set up by extension of the inflammatory process from an adjacent viscus as the pancreas or the gall bladder is true and the symptoms and indications for treatment are very similar.

Perigastric adhesions as sequelæ of gastric ulcer are due to the gradual involvement of the serous coat, by the extension of the ulcerative process, with a localized peritonitis as the result which secures the adhesion of the infected area to that organ or organs with which it comes in contact. In 226 cases of chronic ulcer of the stomach, collected by Fenwick, postmortem examina-

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