

Still more striking are the phenomena found in small intestine lesions. The small intestine is a long tube and one might have expected at least an approximate indication of the level of the intestinal lesion from the level of the maximum point of hyperalgesia on the body wall. But not so. However high or low within the limits of jejunum and ileum the lesion may be if it produces a hyperalgesic area the maximum point is invariably at the same level on the body wall—that is, at the junction of the upper and adjacent fourths of a line drawn from the umbilicus to the symphysis pubis.

As far as my experience goes the same conditions obtain in lesions of the great gut. Certainly lesions from the level of the splenic flexure downwards to the rectum when they do give rise to the reflex, produce it at exactly the same level as one another—that is, at the junction of the lowest and adjacent fourths of a line drawn from the umbilicus to the symphysis pubis.

One is forced to the conclusion that in connexion with each of these separate parts of the gut a common factor must exist. That is to say, a structure which is invariably at the same level in relation to its own segment of gut and one which under certain pathological conditions is capable of producing a hyperalgesic area of skin and subcutaneous tissue.

Now we know that these three parts of the gut possess three structures—namely, the pyloric sphincter, the ileo-colic sphincter, and the internal sphincter of the anus, whose anatomical position is constant, and each of which is developed from the same musculature. Moreover, these sphincters derive their nerve-supply from the same nervous outflow—namely, the thoracico-lumbar outflow of sympathetic nerves—whereas all the remaining musculature of the intestine (by far the major portion) is supplied by fibres from the bulbo-sacral outflow by way of the vagi and pelvic nerves.

No less an authority than the late W. H. Gaskell<sup>1</sup> held the opinion that the musculature from which the sphincters of the gut were developed belonged originally to the layer of subdermal muscles underlying the ventral skin of the body wall, and that at one time when the distance between the respiratory chamber and the cloaca was short, they formed a circular layer surrounding the entire length of the gut, but that with the subsequent elongation of the intestine the continuity of this muscular layer was broken, and the muscle fibres became grouped at points of physiological importance—that is to say, at the pylorus, at the ileo-colic junction, and at the internal sphincter of the anus.

It is a physiological fact that these three sphincters conform to the rest of the dermal musculature, not only in their innervation, but also in their behaviour to the action of adrenalin, thus showing that their characteristics are those of the dermal musculature and not of the neighbouring muscles of the gut. It may not be such a "far cry" from the gut (at least from the sphincters of the gut) to the subcutaneous tissue after all, and it seems probable that at least the middle-line reflexes are, in fact, sphincter reflexes, and that the conditions which produce those reflexes are those which especially irritate or perhaps produce spasm of those muscles.

It is common knowledge that violent peristalsis of the gut may cause severe pain and yet produce no hyperalgesic area of the body wall. Are those the cases in which for some reason the true sphincters remain unaffected? And does hyperalgesia of the skin and subcutaneous tissue only obtain when the muscles which have been shown to belong to the vaso-dermal system become sufficiently irritated?

With regard to the hyperalgesic areas found in connexion with lesions of the appendix, gall bladder, and Fallopian tube, it is at least conceivable that these organs may possess a physiological sphincter derived from the same musculature as the sphincters of the intestine and having the same morphological relationship to the subdermal musculature of the ventral body wall, but whatever be the ultimate truth, that there is a great living principle at the root of those phenomena I am assured.

Owing to the great courtesy and kindness of Major E. Distin Maddick, I was able to illustrate the lecture by a series of kinematograph films showing the actual application of the tests and the response of the patients.

References.—1. Symptoms and their Interpretation. 2. Surgical Congress, 1914. 3. The Clinical Anatomy of the Gastro-intestinal Tract. 4. The Involuntary Nervous System.

## SPINAL INJURY WITH RETENTION OF URINE;

### THE AVOIDANCE OF CATHETERISATION.

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DURING the three months from mid July to mid October last 66 cases of gunshot wound of the spine were admitted into the observation wards at No. 14 Stationary Hospital, Boulogne. The cases arrived from 24 hours to seven days after being wounded, and were kept in this hospital for an average of three weeks, especial attention being paid to the condition and treatment of the urinary system. Of the 66 cases 49 had fractures of the vertebrae, proved by X ray or autopsy. In 17 cases no definite fracture could be demonstrated by X rays, the passage of the bullet close to or grazing the spine having apparently been sufficient to injure the cord. In some a fracture present may not have been detected as there is considerable difficulty in obtaining an X ray which shows all details in gunshot wounds of the spine. Of the 49 cases with definite fracture 10 were in the cervical region, most of them in its lower part, 28 were in the dorsal region, and 11 in the lumbar region.

While the cases were under observation there were 21 deaths: (a) 2 due to high cervical injury and respiratory failure; (b) 2 due to direct infection of the meninges and ascending meningitis; (c) 9 due to complicating injuries and diseases (hæmothorax and broncho-pneumonia 4, gas poisoning 2, severe wound with mitral disease and cystitis 1, injury to colon and septicæmia 1, broncho-pneumonia 1); (d) 7 due to pyelo-nephritis; and (e) 1 to rupture of the bladder.

Of the 66 cases, 50 suffered from retention of urine, and 16 were of a milder type, micturition being normal, or nearly so. Excluding the latter, 7 out of 50, or 14 per cent., died from pyelo-nephritis during the period of observation. The average interval between wounding and death from this cause was 21 days, the shortest 8 days, and the longest 34 days. The mortality from pyelo-nephritis at a later date is much higher; by February, 1917, 339 cases of spinal injury had been admitted to the King George Hospital, and of these 160, or 47 per cent., had died, practically all from urinary infection.<sup>1</sup> Colonel Charters Symonds states that: "Of those who survived to reach the base hospitals probably the majority succumbed to the effects of renal infection within a few weeks."<sup>2</sup> At Netley during the last five months of 1917 the mortality was 65 per cent. of the cases admitted.

*Methods of observation.*—In addition to the usual details, as soon as possible after admission a diagram of the neurological condition was made out, a specimen of urine obtained and sent to the laboratory, and an X ray taken. The indications for or against operation were discussed, and when considered advisable it was undertaken. The method of treating the bladder condition was decided on. Further, the urine of each patient was examined daily, and at intervals specimens were sent to the laboratory for bacteriological report.

### *The Urinary Tract.*

In gunshot wounds of the spine with retention of urine the surgeon's objectives as regards the urinary tract are two: (1) The avoidance of infection; (2) the establishment of a condition of automatic micturition known as "the automatic bladder," "periodic reflex micturition," "the infantile bladder," or "active incontinence of urine." The first is the more important, since the second follows as a rule when infection is avoided or is mild in nature. By the avoidance of urinary sepsis in cases of complete transverse lesion of the cord the patient may be saved from pyelo-nephritis and early death. In cases with some prospect of recovery he may be saved from his most urgent danger and not deprived of his chance of cure by a complication.

The general belief is that infection is carried as a rule by instrumentation, and this is borne out by the results of examination in the laboratory of specimens of urine taken on admission of the 50 cases of retention in this series.

Ten cases had not been catheterised before admission, and only one of them, or 10 per cent., showed evidence of urinary infection, mild in character, and due to *B. coli*. There were no deaths from urinary sepsis amongst these 10 cases.

Forty cases had been catheterised before admission, and of these, 31, or 77·5 per cent., showed evidence of urinary infection. There were seven deaths from urinary sepsis, a mortality of 17·5 per cent.

The infecting organisms were: Coliform bacilli, 15 cases (urine acid 11, alkaline 4); mixed infection bacilli and cocci, 10 cases (all with alkaline urine); streptococcus 4 (urine acid 3, alkaline 1); staphylococcus, 1; *B. pyocyaneus*, 1.

It follows that in most cases catheterisation carries the first infection from the introducer's hands or the patient's glans penis or penile urethra; it is also possible that infective bacteria may be excreted by the kidneys or reach the bladder by the urethra without catheterisation. Urine lying stagnant in the urethra owing to paralysis of the ejaculator urinæ may also be a contributing factor.

#### *Cystitis without Catheterisation: Auto-infection.*

As to infection without catheterisation, Sherrington stated in 1900: "I have never seen cystitis ensue after spinal traumatism in laboratory animals, although the animals have been kept under observation for many months."<sup>3</sup> All physiologists, however, do not agree on this point. Cystitis is said to occur in the cat, coming on with hæmaturia, while expression of the urine is being carried out. Two cases of this series support the possibility of this occurrence in man.

1. Pte., 42. Wounded Sept. 27th, 1918; lying out five hours. Admitted under my care on 29th, no catheter having been passed. Large wound of entry just below angle of left scapula and a right-sided hæmothorax. His lower limbs were paralysed and flaccid. Analgesia extended to a little below upper border of area for seventh dorsal segment; on stimulating soles slight flexor response. His bladder was distended. The urine was acid and contained blood in deposit, a few epithelial casts, and a few pus cells. The infecting organism was *B. coli communis*.

2. Pte., 24. Wounded August 23th, 1918. Admitted to observation wards on 30th without catheterisation. Wound of entry just to right of fifth dorsal spine; X ray showed shrapnel ball localised in body of sixth dorsal vertebra. The lower limbs were paralysed and flaccid; flexor response in toes; line of analgesia was just above upper border of area for seventh dorsal segment. His bladder was distended. The urine was clear and acid, albumin was present, and deposit contained many red blood corpuscles and epithelial cells; no pus cells and no organisms. His retention was treated by expression only, but a few days later infection due to *B. coli communis* supervened, the urine remaining acid.

It seems certain then that infection occasionally occurs in man without catheterisation: (a) It may reach the bladder by the urethra, probably by far the more common route. Incontinence of fæces renders it difficult to keep the scrotum and adjacent parts clean. The periodical flushing and emptying of the urethra is also absent, and urine may lie stagnant in the urethra. (b) Organisms may be excreted by the kidneys. Most of these cases suffer from severe constipation in the first stage of the injury. Gastro-intestinal disturbance with tympanites and vomiting also occur fairly frequently and organisms may find their way from the gastro-intestinal tract into the blood stream from which they may be excreted by the kidneys. Organisms may also be absorbed from septic wounds or bedsores and lead to infection of the urinary tract.

If infection reaches the bladder first, by what route does it usually travel to the kidneys? David, of Chicago, has recently done some experimental work in this connexion.<sup>4</sup> Cultures of *B. coli communis* were injected into the bladders of a series of dogs. (1) Into non-obstructed and non-traumatised bladders; (2) into obstructed and traumatised bladders. In the first group it was found that the urine may contain *B. coli* a month after the infection, although the tissues of the urinary tract show no microscopic evidence of its presence. Moreover, the ureter and renal pelvis gave positive cultures in 2 out of 7 cases, and as in these cases the ureteral and periureteral lymphatics were free from infiltration it is concluded that the ascent of infection took place through the lumen of the ureter. In the second group there was severe cystitis and the infecting organisms were found in the ureter and renal pelvis in 10 out of 12 cases. Histological examination of the ureters again led David to the conclusion that the ascent of infection usually took place through the lumen of the ureter, and only occasionally through the ureteral or periureteral lymphatics.

Obstruction was found to be a more important element than the traumatism used (washing out the bladder with turpentine) in producing cystitis and spread of infection. Regurgitation of fluids through the ureteral orifices has recently been shown to occur in adults with lesions of the urinary tract, by taking a series of radiograms<sup>5</sup> after filling the bladder with a 10 per cent. solution of thorium nitrate.

It is possible that the ascent of the ureter by the infective agent may be a process of growth along the microscopical crevices in its mucous membrane. This would account for its progress in spite of the opposing urinary current. Extension of inflammation, which takes place in other tubes and ducts of the body—for instance, in the bile and parotid ducts, the Eustachian and Fallopian tubes—may be sometimes of a similar character. We must also remember, however, Bond's demonstration of ascending currents in mucous tracts.<sup>6</sup>

#### *Methods of Treating Retention.*

While admitting the possibility of an auto-infection, the safest assumption for the surgeon is that infection as a rule is not due to this cause, and his aim must be to prevent the introduction of sepsis by any method adopted to relieve retention of urine. To avoid infection when catheterisation is used the first necessity is the carrying out of rigid and continued precautions. But under war conditions, in spite of every effort, in the majority of catheterised cases the urine is grossly infected when the patient reaches the base hospital. Even under conditions of peace catheterisation is recognised to be attended by grave danger, and is frequently followed by cystitis and fatal pyelonephritis.

The following methods aim at the complete avoidance of catheterisation: (1) Allowing distension and overflow to take place and to continue without catheterisation; (2) regular emptying of the bladder by pressure—i.e., expression of the urine; (3) early suprapubic cystotomy and drainage; (4) early temporary paralysis of the sphincter by dilatation—a suggested new method to be described later.

#### *I. Distension and Overflow.*

In this method the bladder is allowed to distend until overflow takes place, no catheter being used. It is claimed that no infection of the urine occurs and that cystitis does not develop. It might be feared that the detrusor muscle would not recover tone and that periodic voluntary micturition would not develop, but experiments in animals support the possibility of successful results.

After complete transection of the cord above the upper sacral roots in the dog and the monkey,<sup>7</sup> "For a certain period there is complete retention of urine accompanied by a lax condition of the bladder which allows great over-distension of the viscus with a considerable degree of spasm at the neck of the bladder and of the urethra, so that to the passage of a catheter or to abdominal manipulation a considerable resistance at the proximal end of the urethra is presented.

If the retention at this stage after the transection be not relieved, urine begins to leak away from the over-distended bladder, and escapes from the urethra drop by drop..... Hæmaturia may also result but is not complicated by cystitis..... the laxity of the bladder and the resistance of its neck are both found to diminish. Associated with this increase in tone of the bladder wall, it is now found easy to empty the bladder by abdominal manipulation, for after the passage of a certain amount of urine the bladder contracts down upon the vesical contents. Periodic spontaneous micturition quickly develops and is readily provoked reflexly by stimulating the perineum or hind limbs.

The bladder, however, is not completely emptied..... Excision of the lower part of the spinal cord is eventually followed by periodic micturition, after the bladder has passed through similar stages."

The sequelæ of complete division of the spinal cord have been shown during the war to be similar in man to those occurring after its division in laboratory animals.<sup>8</sup> Three stages are described:—

1. *The stage of muscular "flaccidity"* corresponding to the period of shock in the distal end of the spinal cord. There is retention of urine due to spasm of the sphincter. This stage usually lasts from one to three weeks.

2. *The stage of reflex activity.*—This stage may never appear when the patient suffers from toxæmia due to cystitis, pyelonephritis, bedsores, or severe suppurating wounds.

When the condition does develop the reflexes gradually return and sometimes become very active. The contents of the bladder and rectum are voided automatically, as a rule during the third week. My own observations lead me to the conclusion that the approach of this stage is indicated by the passage of urine from the still partially distended bladder, at first in small amounts of from two drachms to four ounces at intervals of from 5 to 20 minutes. The contraction of the sphincter is gradually inhibited, and the detrusor recovers tone. The amounts discharged gradually become larger and the intervals longer. At a later period almost complete emptying of the bladder may take place. Early in this stage, if catheterisation has been carried out, it may be discontinued. In complete division of the cord above the lumbar region stimulation of the abdomen, thigh, or soles of the feet may cause the bladder to empty itself when the contents are much less than the amount that usually acts as a stimulus and causes it to evacuate. These afferent stimuli have no effect after the destruction of the lower lumbar and the sacral roots.

3. *The stage of toxæmia or the septic stage.*—This stage is brought about by toxic febrile complications, and in it the reflex activity of the distal portion of the cord gradually fails. The toxæmia depresses the reflex activity of the isolated part of the cord, and the failing activity results in less complete evacuation of urine or even sometimes in recurrence of retention. Resistance to bacterial invasion, whether of bed-sores, wounds, or the urinary organs, is diminished and so toxæmia is increased. This stage is one of great misery and usually terminates in death. In many cases allowing distension and overflow to take place and absolutely avoiding catheterisation may be successful in preventing its occurrence.<sup>9</sup> Major P. A. Besley, U.S.A., advocates this procedure and describes successful cases. Among the 50 cases of retention admitted to the observation wards not one had been consistently treated in this manner. There were, however, six patients who had been forced to lie out after being wounded unrelieved for periods of from eight hours to four days, and two of them had reached the leaking stage. Catheters were passed at casualty clearing stations, and they arrived at this hospital with severely infected bladders. Three of these cases died here, two from pyelonephritis and one from the severity of his injuries. One patient developed an early automatic bladder and two were sent to England with their condition ameliorated, their bladders being in the early stage of automatic action and their urines acid and clear.

It is well to remember that when the abdominal wall is paralysed the bladder may be much distended without suprapubic dullness being present. Abdominal distension usually accompanies this condition.

Certain objections are made to the adoption of this procedure. In partial lesions there may be severe pain, but this only occurs in a small proportion of cases and can be relieved by morphia. Respiratory or cardiac action may be mechanically interfered with, and this may be an important factor in cases with hæmothorax, not an infrequent complication. Also a certain amount of shock may be caused by the stretching of the bladder wall, increasing the surgical shock already present. Doubt has also been expressed as to whether the muscle of the stretched and thinned bladder wall will ever recover its tone. Vesical hæmaturia, which may be severe, may follow undue distension of the bladder, and from the formation of intravesical clots may necessitate catheterisation. During the present investigation it became evident that when once catheterisation had been resorted to and cystitis developed this method was dangerous, as it tended to increase the cystitis and hasten the advent of renal complications. Cystitis from auto-infection is also a contra-indication. A more extended trial of this method, which had been practised by American surgeons, is desirable in British hospitals in peace time.

## II. Expression of the Urine.

This method is frequently used for emptying the bladder during experiments on animals. Provided the sphincter is not spasmodically contracted the bladder can be nearly emptied without difficulty. The evacuation is in some cases rendered more easy by preliminary stimulation of the soles of the feet, thighs, or lower part of the abdominal wall. The open hand is applied to the abdomen, and the distended bladder is gently grasped. Pressure is then made, combined with a squeezing movement; much force must not be used.

Micturition once started, the pressure may be relaxed a little, as the action often continues spontaneously. Assistance may sometimes be given by the patient breathing deeply.

The greatest difficulty is in the stage of spinal shock and sphincter spasm. Expression may be facilitated by morphia;  $\frac{1}{4}$  gr. may be given and repeated in an hour if necessary. The application of heat to the perineum or turning the patient on his side may also be of use. To produce inhibition of the contraction of the sphincter, apocodeine, pituitrin, and ergotoxin followed by adrenalin<sup>7</sup> have been suggested, but were not tried in this series of cases.

An attempt was made at this hospital to test the value of expression of urine. Seven cases were admitted which had been treated by this method before admission. *With one exception they were free from urinary infection on admission.* Unfortunately 2 died within 48 hours from the severity of their injuries. In 3 of the 5 survivors the urine remained sterile until their discharge to England with bladders in the early stage of automatic action. In 2 cases, including the one already infected on admission, cystitis developed necessitating washing out of the bladder.

With regard to the lesions in these 7 cases, of the 2 cases in which cystitis developed one had signs of a complete lesion at the level of the sixth dorsal segment, and in the other the injury was at the level of the seventh dorsal segment. The three whose urine remained sterile suffered from: (1) a Brown-Séquard lesion at the level of the fifth cervical segment; (2) a partial lesion in the lower dorsal region; (3) a lesion of the cauda equina.

In nine other cases in which expression was undertaken at this hospital, catheters had been passed up the line but the urine was normal on admission. One patient died from a complication; in another, a man dying from septic meningitis, a rupture of the bladder was found at the autopsy. In four the urine remained sterile, in three mild cystitis supervened, but the seven surviving cases went to England with automatic bladders and in good general condition.

With regard to the positions of the lesions in these cases:—In the four which remained sterile, one was at the level of the fifth cervical segment and the other three were lesions of the cauda equina. Of the three in which cystitis supervened, one was at the level of the fifth cervical segment and the other two were lesions of the cauda equina.

Expression of severely infected bladders proved dangerous and should, I think, never be attempted. Even moderate pressure may then rupture a thinned bladder wall, or the manipulation may aggravate existing cystitis, or vesical hæmorrhage. As it probably also encourages regurgitation of urine into the ureters, in septic cases it should not be practised.

When catheterisation has not been resorted to, or when the urine is normal, expression has been successful. But as cystitis may undoubtedly come on without catheterisation, and in view of the difficulties and dangers just enumerated, the adoption of this method can only be advocated in those cases in which it is easily accomplished and in which the urine is not infected.

## III. Early Suprapubic Cystotomy and Drainage.

It has been suggested by Thomson Walker that the bladder be opened above the pubes at the earliest possible moment—i.e., at the C.C.S. and before catheterisation. He advocated the insertion of a Pezzer's suprapubic catheter, and that the bladder be kept clean by drainage and irrigation. One case was admitted under my care which had been treated in this manner, and his bladder condition for the few days he was here was satisfactory.

This procedure while having the great advantage of avoiding catheterisation is open to the following objections:—(1) With the flaccid condition of the abdominal wall in some of these cases it is difficult to keep the appliance watertight. (2) Drainage of the bladder is almost certain to lead to cystitis, and washing out of the bladder will be required. (3) Drainage of the bladder for any long period practically means the abandonment of any attempt to establish an automatic function, and in cases in which there is a possibility of recovery from paralysis the bladder may be permanently damaged by the adoption of this course.

## IV. Temporary Paralysis of the Sphincter.

During the trial of expression it was found that when the spasm of the sphincter was very obstinate the passage of a large-sized instrument, which was allowed to remain in the

urethra for a few minutes, was followed by marked facilitation of expression and the early onset of overflow. The idea of producing early paralysis of the sphincter vesicæ by instrumental dilatation then occurred to me. I believe that dilatation with suitable instruments might produce temporary incontinence, in which case repeated catheterisation might be avoided and the stage of reflex activity reached without infection of the bladder. I had no suitable case, but I propose to give this plan a trial when next I have.

Very great care as regards surgical cleanliness would, of course, be necessary. The condition aimed at is analogous to that produced by stretching the sphincter of the rectum before the operation for hæmorrhoids, or to the temporary incontinence which follows the use of a large-size speculum in the female urethra.

*Cases in which the Bladder became Automatic shortly after the Spinal Injury.*

Among the cases admitted to the hospital there were four in which automatic action of the bladder came on very early. Three of them had not been catheterised, and in all four the urine was free from infection. (It is worthy of note that of ten uncatheterised cases, three developed early automatic bladders.) As these cases seem remarkable I will give brief notes of each.

CASE 1.—Pte., aged 19; wounded on Sept. 2nd, 1918, the missile entering just below spine of second dorsal vertebra. He was lying out for 24 hours, and thinks he passed water unconsciously during that time, as his clothing was noticed to be wet. He was admitted under my care on Sept. 5th. There was analgesia to a little below level of area for fifth dorsal segment with absence of tendon reflexes below. Complete paralysis of lower extremities. On stimulating the sole there was slight flexion of the toes. Superficial abdominal reflexes absent. Breathing was mainly diaphragmatic. A rifle bullet was localised in the middle line 7-8 cm. from the skin of the back, opposite body of fifth dorsal vertebra. No fracture showed in the plates (antero-posterior), but the missile is unlikely to have reached its position without having caused one. The bladder could be felt above the pubes. On lightly pressing over the bladder, evacuation commenced and was apparently complete. No catheter had been passed and the urine was normal. Micturition occurred unconsciously every two or three hours in quantities of several ounces. No cystitis supervened and the patient was sent to England on Sept. 27th.

CASE 2.—Pte., aged 40; wounded on Sept. 3rd, 1918; lying out for four hours; did not reach C.C.S. until some hours later. He was admitted here on the 7th. Entrance wound in left posterior axillary line between ninth and tenth ribs. An X ray showed small fragment of shell between eleventh and twelfth dorsal vertebra in middle line. Complete paralysis of lower extremities; absence of superficial and deep reflexes. Line of analgesia corresponded to upper border of area for first lumbar segment. He had left-sided hæmothorax, which was subsequently aspirated. Also band of herpes on left side in area corresponding to tenth dorsal segment. He had never been catheterised, his bladder was not distended, his urine was normal and was discharged in quantities of several ounces every two or three hours. He was evacuated to England in good condition on Sept. 27th.

CASE 3.—L.-Cpl., aged 37; wounded Sept. 27th, 1918; reached field ambulance five hours after wound. A catheter was passed once on the ambulance train, and he reached this hospital on the 29th. Wound in left posterior axillary line. He had paralysis of lower extremities, with absence of superficial and deep reflexes. Analgesia complete below upper border of area for third lumbar segment. An X ray showed fractures of bodies of twelfth dorsal and first lumbar vertebra; missile not shown on plate. His bladder was not distended, but was evacuating normal urine in small quantities frequently. The periods between evacuation lengthened, and on Oct. 2nd the bladder was definitely automatic. He was sent to England without cystitis on Oct. 21st.

CASE 4.—Cpl., aged 22; thrown from horse on Sept. 3rd, 1918, and fractured bodies of fifth and sixth cervical vertebrae, as shown by X ray. Paralysis of lower extremities and abdominal and chest walls; breathing diaphragmatic. On stimulating the soles there was flexor response in the toes and thighs. Skin and tendon reflexes were absent. Line of analgesia of trunk a little below upper border of area for sixth cervical segment. Upper extremities partially paralysed. He had not been catheterised; urine normal. The bladder was not distended, but on pressure over it a discharge of urine took place. Micturition was automatic until his death from respiratory failure on Sept. 5th.

*Hæmaturia.*

Among the 50 cases with bladder trouble in this series there were seven cases of profuse early hæmaturia without complicating injuries of the urinary tract. In these cases it came on about 48 hours after injury. Four of the seven cases died, and the occurrence of this type of hæmaturia seems to affect the prognosis unfavourably. This hæmaturia has been attributed to vaso-motor disturbance, and the post-mortem appearances support the view advanced by Roussy and Lhermitte that it is vesical in origin.<sup>10</sup>

In four cases hæmaturia came on later and was attributed to the use of urotropine. It occurred when the drug had been given in 10 gr. doses, six hourly, for a period of from one to three weeks, and quickly ceased on stopping its administration. No harmful effects were observed. In one case the drug was given to a patient without bladder trouble of any kind. Severe temporary hæmaturia with the characteristics just mentioned was produced

*Prophylactic Measures.*

The preponderance of the mortality from cystitis and renal infection over that from all other causes should be borne in mind from the first in any case of spinal injury with retention of urine. *The patient is as much a urinary case as a spinal case.* The administration of urotropine with acid sodium phosphate should be begun at the earliest opportunity and before infection can have occurred.

I consider that vaccines should also be used as a prophylactic measure. *B. coli communis* is the commonest cause of infection, and moderate doses of *B. coli* vaccines might be used with advantage before infection occurs. The use of vaccines in the treatment of infection of the urinary tract has been favourably reported on from time to time, and in some cases of this series autogenous vaccines had a definite beneficial effect.

*Conclusions.*

The very large number of deaths from ascending infections after catheterisation renders it essential to endeavour to discover some other method of relieving the retention in these cases of spinal injury. It should be borne clearly in mind that retention is only a temporary phase, its average duration in the absence of infection being less than three weeks.

The observations I have made on this series of cases leads me to conclude that passive treatment—i.e., allowing distension and overflow to take place—should be given a thorough trial, and I think that attempts at expression should be made from time to time. Assistance may be found in the measures enumerated, the administration of drugs, especially morphia, the application of heat, &c. When dribbling of urine commences expression is usually quite easy and the bladder can be emptied partially at regular intervals. This diminishes the stretching and thinning of its walls and should allow its muscle to recover tone more rapidly. If complications of the injury (hæmothorax, &c.) make it advisable to relieve the distension, temporary paralysis of the sphincter by instrumental stretching might be tried. Even moderate stretching renders expression a simpler and easier proceeding in the earlier and spasmodic stages of retention. It is of the greatest advantage that the treatment of the bladder from the date of injury until the automatic stage is reached should remain in the hands of one person.

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*Note by Mr. A. E. WEBB-JOHNSON.*

This concentration of cases of spinal injury was arranged in the hope that something might be done to improve the lot of these men. I am glad to have the opportunity of expressing my appreciation of the devotion and zeal shown by Major P. N. Vellacott, R.A.M.C., and the nursing staff of the observation wards. Specialisation, as a rule, is advantageous to the patients, but in cases of this character doubt has been expressed whether the strain, especially in the early stages, is not too great for the patients and nurses. The heavy mortality in the early days has a depressing effect on both patients and nursing staff, but the advantages of concentration and specialisation were so great as far to outweigh the disadvantages, and the lot of these men was much better than it could have been had they been distributed to all hospitals in the base.

The primary object of concentrating these cases was to give a trial to different methods of treating the retention of urine so frequently present in spinal injuries and to ascertain, if possible, the best method to adopt in order to avoid septic infection and to encourage the establishment of automatic reflex micturition.

We tried to get a large series of cases sent down from the front without any catheterisation having been carried out, but this proved extremely difficult. British surgical teaching has been that when there is retention of urine in cases of spinal injury a catheter should be passed to relieve the condition. It therefore happened that only comparatively few cases were able to pass through the network of medical units on the way from front to base without some medical



