

THE VALUE OF INTERMITTENT CATHETERISATION IN THE EARLY MANAGEMENT OF TRAUMATIC PARAPLEGIA AND TETRAPLEGIA

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IN spite of the advances made in the urological management of traumatic paraplegics as well as tetraplegics in the last 10 years or so, there is still a considerable discrepancy of opinion amongst specialists in this field regarding the best method of preventing infection of the urinary tract in the immediate and early stages following spinal cord injuries. It is true that the indiscriminate use of suprapubic cystostomy, considered during World War II as the method of choice in the immediate management of the paralysed bladder, has disappeared. The detrimental effects on the urinary tract as a result of this method have clearly disproved the concept, at one time widely held amongst urologists and other workers in this field, that suprapubic drainage could prevent ascending infection of the urinary tract and other complications (Guttmann, 1947, 1953). Today there is general agreement that this method is indicated only in the rare instances of a direct injury to the urethra by the accident or by a pre-existing severe urethral stricture which makes urethral catheterisation impossible. Alas, in recent years suprapubic drainage as early urological management in paraplegic patients has been revived in the form of tubeless or what is called cutaneous vesicostomy in the U.S.A. by Blocksom (1957), Lapidès *et al.* (1960, 1962, 1964), Arduino and Miller (1960), Felton and Read (1960), Leal, Scribitis and Lloyd (1963). However, strong criticisms have been made by American physicians and surgeons, amongst them those with extensive experience in paraplegia (Bors, Comarr, Ebel, Habib, Susset, Talbot, 1963). Comarr in particular has dissociated himself from Lapidès' statement that 'if the bladder does not come around within two weeks after injury this is the indication to do it'. It may also be noted that Lloyd, who himself is in favour of cutaneous vesicostomy instead of the use of a permanent suprapubic mushroom catheter in the *occasional* case only when such form of bladder drainage becomes necessary, made his view abundantly clear: 'to do frequent and routine cutaneous vesicostomy early in the course of paraplegia is inexcusable'. Krahn *et al.* (1964) stated that all their seven patients undergoing the Lapidès vesicostomy were failures and required intubated drainage later. Laskowski and Brantley Scott (1965) performed the Lapidès vesicostomy in 45 patients, 44 of them with spinal cord lesions, who (1) were unable to empty the bladder effectively, (2) required prolonged tube drainage and (3) had a poor prognosis for neurologic recovery (no detailed explanation was given about the meaning of point 3). Although there were no deaths, wound infection was the most common early post-operative complication (eight cases), the others being necrosis of the distal part of the bladder flap (five), prolonged urinary leakage (two), atelectasis (one), paralytic ileus (one). The most common late complications were: technical difficulty with the collecting device (eight cases), encrustations on skin flap due to growing hair (four), bladder

calculi (four), tight stoma (three), renal calculi (two), vesical eversion (one). Moreover, squamous metaplasia was found in all 13 cases where biopsies were performed and cystitis glandularis occurred in two patients. These tissue changes may, as is known, lead later to carcinomatous development. Yet, incredible as it may seem, in spite of all these results the authors consider the incidence of post-operative complications as acceptable!

It is now generally agreed that the method of choice for the early management of the paralysed bladder is urethral catheterisation. However, authors still differ whether at this stage urethral drainage should be done by continuous drainage with an indwelling catheter with or without closed receptable system and with or without irrigations, or by intermittent catheterisation.

The Method of Intermittent Catheterisation. At the National Spinal Injuries Centre, Stoke Mandeville Hospital, intermittent catheterisation has always been the method of choice in the acute stage of any cause of paraplegia, including in particular traumatic paraplegia and tetraplegia, if 12-24 hours after injury micturition did not occur spontaneously or reflexly. The reason for non-interference by any instrumentation during this period is that as a rule the paralysed bladder at this stage is not sufficiently distended to warrant immediate drainage by any method. Moreover, in many cases of spinal injury the rate of renal secretion is retarded due to traumatic shock. Fluid intake is restricted during this period, especially in tetraplegics, because of the disturbed water metabolism resulting from the loss of vasomotor control, and the belief that increased fluid intake will establish micturition by reflex detrusor action at this stage is erroneous. If, after 12-24 hours, voluntary or reflex function of the bladder had not developed and gentle manual pressure upon the bladder region or digital massage per rectum has proved unsuccessful and the bladder has become distended, intermittent catheterisation is instituted. This is done two or three times within 24 hours, according to fluid intake and renal secretion, and in male patients is carried out personally by the medical officer in charge of the case, using the non-touch technique described by one of us (Guttmann, 1949, 1953, 1958, 1961). The reasons why intermittent catheterisation in the immediate and early stages of paraplegia is preferable to immediate continuous drainage by indwelling catheter can be summarised as follows:

1. Immediate and early drainage of the paralysed bladder by indwelling catheter of any type inevitably leads to early bladder infection which in the majority of cases occurs within 2-4 days if not within 24 hours. Therefore, in this respect there is really no difference between indwelling catheter drainage and drainage by suprapubic cystostomy whether with or without tube insertions.

2. The view held by urologists for so many years that, with intermittent catheterisation, the paralysed bladder cannot be kept sterile longer than two days is absolutely unfounded, provided proper aseptic precautions are taken. That the old prejudice against intermittent catheterisation has not been overcome is shown by the astonishing statement made as recently as 1959 by Prather in the U.S.A.: 'it is generally agreed that in the management of spinal cord injuries intermittent catheterisation drainage is the worst form of treatment which can be used.'

3. An important reason for first using intermittent catheterisation and not an indwelling catheter is to allow the urethral mucosa to become accustomed gradually to the foreign body. It must be remembered that in the state of spinal shock and flaccidity, the tone of all tissues, including that of the urethral mucosa, is greatly diminished. As a result, the threshold to pressure is lowered. Consequently, an

indwelling catheter, especially one of larger size, kept *in situ* without being changed for several days or weeks tends to produce ischaemia of the tissue by constant pressure in the urethra resulting in a pressure sore leading to abscess and eventually to that most dreaded complication, peno-scrotal fistula.

4. In incomplete cord lesions and those complete ones, especially in young people, where early return of voluntary or reflex function can be expected provided no bladder infection has occurred, intermittent catheterisation allows some distension of the bladder, which represents the physiological stimulus for micturition by setting up the appropriate impulses to the spinal bladder centre and thus promoting early return of detrusor activity in these cases. Using this regime of bladder management, we found particularly in young patients with complete spinal cord lesions about T10, the appearance of automatic reflex-micturition as early as 8-14 days after injury. Therefore, the old teachings of physiologists and neurologists that automatic reflex-micturition occurs only after 6-8 weeks can no longer be accepted dogmatically.

The view strongly held in this Centre is that the paraplegic, in his precarious acute condition, deserves the best and not the second-best chance of preserving sterility of his paralysed bladder and that, particularly in male paraplegics, urethral catheterisation is a medical procedure. It should, therefore, be carried out exclusively by a medical officer familiar with the non-touch technique and not be left to the nursing staff, let alone orderlies or 'technicians'.

Throughout the years, this concept has been consistently adhered to and intermittent catheterisation has continued to be the method of choice in the management of the paralysed bladder during the acute stages of traumatic paraplegia. With increasing experience, it has been found that by using this regime the paralysed bladder can be kept sterile in the great majority of patients not only for many weeks but indeed often throughout the whole period that catheterisation has been needed.

This paper describes the management of the bladder by intermittent catheterisation, the results of treatment and the follow-up of 476 out of 608 traumatic paraplegics and tetraplegics who were admitted to the National Spinal Injuries Centre within 14 days of injury (the majority within 48 hours), over an 11-year period from 1.1.54 to 13.12.64. Preliminary results over a 10-year period with a more limited follow up have been previously reported (Guttmann, 1963; Frankel & Guttmann, 1965).

Technique and Management. *Sterilisation and Lubrication.* All catheterisations on male patients were performed by a doctor assisted by a nurse or a trained catheter orderly. The women were catheterised by state registered nurses. In all cases, the non-touch technique with full aseptic precautions as described by Guttmann (1949) was used. For the first seven years, the external urethral orifice was cleaned before catheterisation with Cetavlon 1:1000, but during the last four years 1 per cent. Savlon solution has been used. Occasionally, male patients have developed inflammation of the glans penis after repeated use of these solutions, and in those cases sterile 4 per cent. boric acid solution was used for cleaning. Previously, we used a catheter lubricant of Glycerin Pulv. Tragacanth with 0.25 per cent. mercuric oxycyanide as a bacteriostatic agent, but the latter was replaced by 0.05 per cent. of Hibitane.

For the first six years, we used rubber Jacques catheters size 8 E.G. which

were sterilised together with the rest of the equipment by boiling in a steriliser in the ward. A few male patients became allergic to the rubber and developed a sterile urethritis, and it was found that the condition cleared up when plastic catheters were used instead; for the last five years, we have, therefore, used plastic Jacques catheters size 8 or 10 E.G. and urethritis is now extremely rare.

For the past two years the catheterisation equipment and the catheters have been autoclaved. The catheter is contained in a 1-inch nylon envelope open at one end which contains the lubricant; the catheter is pulled out of this envelope with the sterile forceps and is ready for use without further lubrication. The equipment as now used and the technique of catheterisation are shown in Figures 1 A-D.

Procedure. Most patients did not need catheterisation during the first 24 hours after injury. After this period they were catheterised two or three times a day according to their urinary output, until they started to pass urine either voluntarily, automatically or by manual and abdominal expression. Most patients, especially the cervical patients, had an initial period of water retention with relative oliguria during the first few days after injury and during this time needed only twice-daily catheterisation; at about the 4th-6th day or soon after there was often a profound diuresis and 3 or 4 litres of urine were often secreted in 24 hours. During such diuresis we temporarily reduced the fluid intake and catheterised the patients four or more times a day. After the diuresis was over, fluid intake was adjusted so that each catheterisation at approximately 9 a.m., 2.30 p.m. and 10 p.m. yielded between 600 ml. and 750 ml. in adults, and every care was taken to see that the bladder never became overdistended. Therefore, at the stage when the patients were being catheterised three times daily and were unable to pass any urine without catheterisation, the fluid output averaged about 2 litres in 24 hours.

Care was also taken to empty the bladder completely as it is known that in the recumbent patients, in particular those with flaccid lesions, the lowest point of the bladder is not necessarily drained by the catheter (Doggart, Guttman & Silver, 1966). Therefore abdominal expression was used at the end of the catheterisation to obtain any residual urine and thus prevent stagnation of urine in the bladder.

As soon as the bladder could be expressed, as is the case with the autonomous bladder in conus-cauda equina lesions, or as soon as an automatic reflex bladder has developed, fluid intake was increased to give a urinary output of 3 to 4 litres for 24 hours. When the residual urine became less than 500 ml., catheterisation was reduced to twice daily; when less than 250 ml., it was reduced to once daily, and when less than 100 ml. catheterisation was usually stopped. However, the residual urine was regularly checked once or twice a week for several more weeks. Cystometrography, and in certain cases cystography, was included to ascertain the functional state of the bladder. The average time between injury and stopping catheterisation in the male completely—*i.e.* without repeating residual urine tests—was 6-7 weeks.

Before 1954, it had been our practice to give prophylactic penicillin and sulphonamides or alternatively Aureomycin during the first week or two of catheterisation. From 1954 onwards, antibiotics were not given routinely as urinary prophylactics, but almost all patients had intramuscular penicillin (or other antibiotics) during the first week or two for the prevention or treatment of chest or other infections. Since the end of the period covered by this paper, we have been trying the effects of a combination of hexamine-mandelate (250 mg.) and methionine

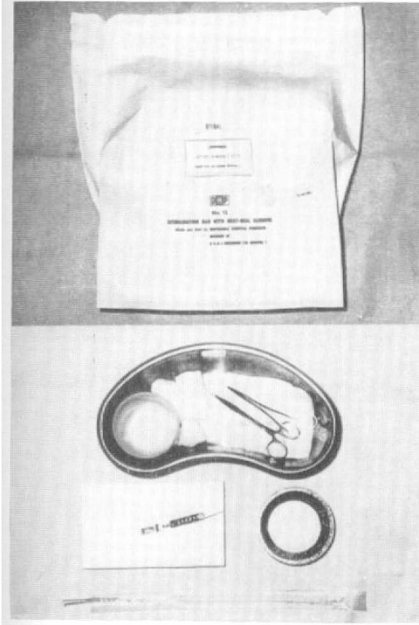


FIG. 1A

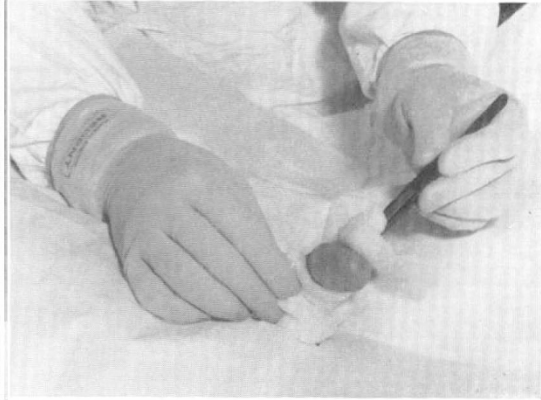


FIG. 1B

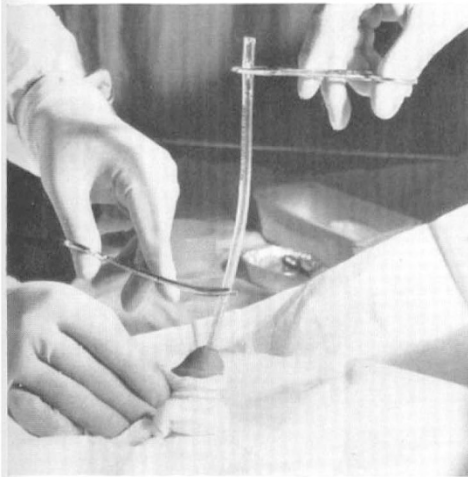


FIG. 1C

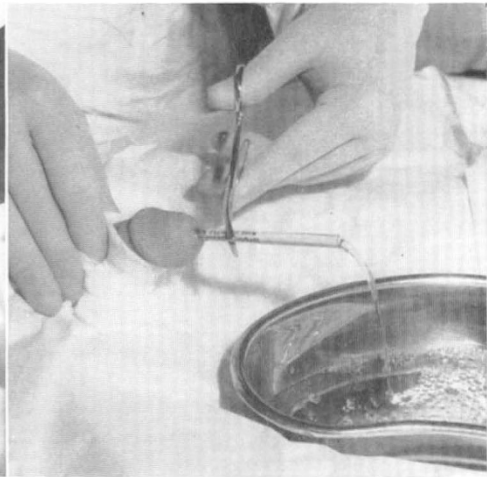


FIG. 1D

Figure 1A—Autoclaved catheterisation pack. The upper half of the photograph shows the sealed paper bag and the lower half shows the contents. Figure 1B—Catheterisation: The penis has been put through the small hole in the sterile paper towel, the foreskin has been retracted and the penis is held with a piece of sterile gauze; the doctor is cleaning the glans with 1 per cent. Savlon solution. Figure 1C—The doctor is gently introducing the already lubricated catheter, the blunt end of the catheter is supported with forceps held by an assistant. Figure 1D—The catheter is in the bladder, it is removed as soon as the bladder has been completely emptied.

(250 mg.) manufactured into one tablet, introduced by one of us (L.G.) as an acidifying agent and called for the time being G. 500¹. This combination obviates the dispensation of the many tablets necessary if these three drugs are taken separately to establish a satisfactory acidity of the urine with a pH at about 5. Thus, instead of 32 tablets per day, only 16 per day of G.500 are given, which, of course, is much less troublesome for the patient. Moreover, once a pH of 5-5½ is achieved the dosage of 16 tablets per day can be gradually reduced to find the appropriate maintenance dosage in the individual cases. It may be noted, however, that G.500 in a dosage of 16 tablets daily was found ineffective in preventing alkalinity of the urine during proteus infection (fig. 2).

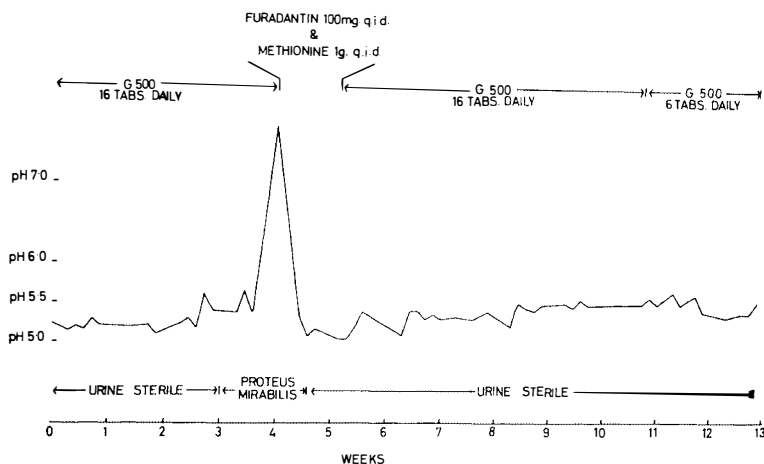


FIG. 2

Urinary pH. of a patient over 3-month period recorded with PYE 79 pH meter. The pH was maintained between 5.0 and 5.5 except during infection with *Proteus mirabilis*, the rest of the time the urine was sterile. When the dosage of G.500 was reduced from 16 tablets per day to 6 tablets per day there was no significant rise in pH.

Assessment of Sterility. Urine was sent for bacteriological examination very frequently, at least once a week, and if infection occurred as judged by the appearance of the urine to the naked eye and confirmed by microscopic examination a systemic antibiotic course was started at once while awaiting the results of culture and sensitivity. During the first four years of the 11-year period if infection occurred it was treated with systemic antibiotics, a temporary indwelling Foley catheter and bladder washouts. More recently indwelling catheters have been used only if there were a severe urinary flare-up. When a temporary Foley catheter was necessary, we used size 16-18 F. with a 5-c.c. balloon and a doctor changed the catheter three times a week by the non-touch technique. If the infection is overcome by antibiotics, Furadantin or sulphonamides, the G.500 treatment follows to keep the urine acid.

Results on admission and during early stages of paraplegia are based on catheter specimens, results on discharge on carefully taken mid-stream specimens

¹This drug is manufactured by Harker Stagg Ltd., Emmat Street, London, E.1.

(except for those patients who were discharged with a permanent indwelling catheter). Specimens were examined within half an hour of collection and if further delay was likely they were refrigerated. We were fortunate in having excellent co-operation from our Pathology Department.

Urine was regarded as sterile if *in the absence of antibacterial drugs* it contained less than 4 white cells per c.mm. and gave no growth on culture. In doubtful cases the examination was repeated. The bacteriological methods used on our material have been described by Milner (1963).

Clinical Material. Six hundred and eight traumatic paraplegics—521 male and 87 female—were admitted within 14 days of injury (62·5 per cent. within 48 hours) during the 11-year period. Their neurological lesions are shown in Table I. Forty-four of these died within three months of injury. Details concerning death in relation to level of the neurological lesion are also shown in Table I, and deaths in relation to the patients' ages are shown in Table II. The causes of death are given in Table III. 61·4 per cent. of the 44 who died had cervical lesions, 43·2 per cent. of those who died were aged over 51. 17 patients had such incomplete lesions that they never needed catheterisation, and 15 patients have not yet been discharged. All these are excluded from further analysis, as are the 56 whose records were incomplete regarding treatment before arrival, sterility on arrival and details of treatment. This leaves a total of 476—409 males and 67 females—for evaluation. Their neurological lesions are shown in Table VI.

Follow-up. Wherever possible, all patients had check-ups at least yearly, but often more frequently, especially those who were infected or had developed hydro-nephrosis or other complications. Check-ups included urine culture, cell and protein counts, blood chemistry, and intravenous pyelogram. In some cases, cystograms and clearance tests were also included. The number who have had check-ups so far as shown in Tables VII and VIII—298 males and 46 females.

RESULTS

Table IV demonstrates the state of the urine on arrival at the Centre related to treatment before arrival. As can be seen, the results where no catheterisation or only intermittent catheterisation had been used by the referring hospital are superior to those where a Gibbon catheter was used and infinitely superior to those where a Foley catheter was used. Already at this stage, a greater percentage of females were infected.

Table V demonstrates the state of the urine on admission and discharge. While the overall sterility of urine was 62·2 per cent., the males catheterised exclusively by the doctor in charge of the case showed 64·8 per cent. sterile urine, the female only 49·3 per cent. In analysing these figures further, only the male patients are considered, as the number of female patients is too small to be assessed in percentage. It was found that of the 92 male patients who were not catheterised before admission to the Centre, 63 (68·5 per cent.) were sterile on discharge; of the 157 who had intermittent catheterisation before admission, 109 (69·4 per cent.) were sterile on discharge; of 45 treated with Foley catheters before admission, 27 (60 per cent.) were sterile on discharge; of the 36 treated with Gibbon's catheter before admission, 23 (63·90 per cent.) were sterile on discharge. Of the 7 infected cases who had intermittent catheterisation before admission, 4 were sterile and 3

TABLE I
Traumatic Spinal Cord Injuries
(admitted within 14 days of injury)

Level of Cord lesion	Total number	Death within 3 months
Cervical	229	27 (11·8%)
T1-T5	62	6 (9·7%)
T6-T12	188	9 (4·8%)
Below T12	129	2 (1·6%)
Total	608	44 (7·2%)

TABLE II
Total Material = 608 (521 Male, 87 Female)
Deaths during Early Stage following Injury = 44 (7·2%)
Male 38, Female 6

	Age					Total	% of deaths
	Under 21 years	21-30 years	31-40 years	41-50 years	51+ years		
Cervical	0	4	3	7	13	27	61·4
T1-T5	1	0	1	1	3	6	13·6
T6-T12	0	3	2	2	2	9	20·5
Below T12	1	0	0	0	1	2	4·5
Total	2	7	6	10	19	44	
% of deaths	4·5	15·9	13·6	22·7	43·2		

TABLE III
Causes of Death

Multiple injuries	4	(2 of these with acute renal failure)
Head injury	8	(6 cervicals)
Pulmonary emboli	17	(8 cervicals)
Other lung complications	11	(9 cervicals)
Coronary thrombosis and heart failure	2	(2 cervicals)
Bleeding peptic ulcers	2	(2 cervicals)
Total	44	(27 cervicals)

TABLE IV

Treatment before Arrival	State of Urine on Arrival	
MALES 409		
	Sterile	Infected
No catheterisation	92	0
Intermittent catheterisation	157	7
Foley catheter	45	61
Gibbon catheter	36	9
Suprapubic	0	2
	—	—
	330 (80·7%)	79
FEMALES 67		
	Sterile	Infected
No catheterisation	12	0
Intermittent catheterisation	17	7
Foley catheter	7	20
Gibbon catheter	4	0
	—	—
	40 (59·7%)	27

TABLE V

Patients admitted within 14 Days
of Injury between 1.1.54 and 31.12.64

MALES 409	FEMALES 67
<i>On admission</i>	<i>On admission</i>
Sterile 330 (80·7%)	Sterile 40 (59·7%)
Infected 79	Infected 27
<i>On discharge</i>	<i>On discharge</i>
Sterile 263 (64·3%)	Sterile 33 (49·3%)
Infected 146	Infected 34
TOTAL MALE AND FEMALE ON DISCHARGE	
Sterile 296 (62·2%)	
Infected 180	

remained infected on discharge; of 61 infected patients who were treated with an indwelling Foley catheter, 31 (50·8 per cent.) were sterile on discharge and 30 remained infected; of 9 patients infected by Gibbon catheter on admission, 5 were sterile on discharge and 4 remained infected; of the 2 admitted infected by suprapubic cystostomy on admission, 1 became sterile following closure of suprapubic drainage and 1 remained infected. This analysis clearly demonstrates the high efficiency of intermittent catheterisation in the prevention and overcoming of infection of the paralysed bladder in the initial and early stages of traumatic paraplegia and tetraplegia.

Table VI shows the neurological lesions of the patients related to sterility of their urine on discharge, in addition to giving their levels and dividing them into complete and incomplete lesions; the lower lesions have been further subdivided into spastic and flaccid. Generally, the results are better for the incomplete lesions than for the complete lesions at any one level. Results are also better for spastic than for flaccid lesions.

TABLE VI
Neurological Lesions and Sterility on Discharge
(Males and Females)

	Total	Sterile on Discharge	Infected on Discharge
Cervical:			
Complete	79	44 (55.7%)	35
Incomplete	102	65 (63.7%)	37
T1-T5:			
Complete	37	22 (59.3%)	15
Incomplete	6	4	2
T6-T12:			
Complete spastic	72	41 (56.9%)	31
Complete flaccid	45	22 (48.8%)	23
Incomplete spastic	23	18 (78.3%)	5
Incomplete flaccid	13	10 (76.9%)	3
Below T12:			
Complete spastic	6	4	2
Complete Flaccid	51	32 (62.7%)	19
Incomplete spastic	12	9 (75%)	3
Incomplete flaccid	30	25 (83.3%)	5
Total	476	296 (62.2%)	180

TABLE VII
Length and Result of Follow-up
(Males)

Years after injury	Number of last check-ups	Sterile on first discharge	Infected on first discharge	Sterile at check-up	Infected at check-up	Originally infected sterile now	Originally sterile infected now
1	84	53 (63.1%)	31	44 (52.4%)	40	2	11
2	42	25 (59.5%)	17	19 (45.2%)	23	3	9
3	53	38 (71.4%)	15	36 (67.9%)	17	6	8
4	37	25 (67.6%)	12	21 (56.8%)	16	2	6
5	26	11 (42.3%)	15	6 (23.1%)	20	1	6
6	21	13 (61.9%)	8	9 (42.9%)	12	3	7
7	15	6	9	10	5	4	0
8	5	0	5	3	2	3	0
9	5	2	3	4	1	2	0
10	10	5	5	5	5	1	1
Total	298	178 (59.7%)	120	157 (52.7%)	141	27	48

TABLE VIII
Length and Result of Follow-up
(Females)

Years after injury	Number of last check-ups	Sterile on first discharge	Infected on first discharge	Sterile at check-up	Infected at check-up	Originally infected now sterile	Originally sterile now infected
1	11	6	5	5	6	0	1
2	7	3	4	3	4	1	1
3	9	5	4	4	5	2	3
4	5	2	3	3	2	1	0
5	3	1	2	1	2	0	0
6	3	0	3	1	2	1	0
7	4	1	3	2	2	1	0
8	2	2	0	2	0	0	0
9	1	0	1	1	0	1	0
10	1	0	1	0	1	0	0
Total	46	20 (43.5%)	26	22 (47.8%)	24	7	5

TABLE IX
Neurological Lesion and Sterility in Males
who have had Check-ups

	Total	Sterile on first discharge	Infected on first discharge	Sterile at last check-up	Infected at last check-up
Cervical:					
Complete	44	22 (50%)	22	21 (47.7%)	23
Incomplete	63	39 (61.9%)	24	35 (55.5%)	28
T1-T5					
Complete	25	16 (64%)	9	13 (52%)	12
Incomplete	4	3	1	3	1
T6-T12:					
Complete spastic	51	28 (54.9%)	23	25 (49%)	26
Complete flaccid	36	16 (44.4%)	20	15 (41.7%)	21
Incomplete Spastic	11	9 (81.8%)	2	8 (72.7%)	3
Incomplete flaccid	5	3	2	3	2
Below T12:					
Complete spastic	2	1	1	2	0
Complete flaccid	29	16 (55.2%)	13	12 (41.4%)	17
Incomplete spastic	7	6	1	4	3
Incomplete flaccid	21	19 (90.5%)	2	16 (76.2%)	5
Total	298	178 (59.7%)	120	157 (52.7%)	141

TABLE X
Hydronephrosis and Reflux Related to
Neurological Lesions

	Hydronephrosis	Reflux
Cervical:		
Complete	4	5
Incomplete	5	2
T ₁ -T ₅ :		
Complete	4	3
Incomplete	0	0
T ₆ -T ₁₂ :		
Complete spastic	5	4
Complete flaccid	8	4
Incomplete spastic	0	1
Incomplete flaccid	1	0
Below T ₁₂ :		
Complete spastic	0	0
Complete flaccid	4	0
Incomplete spastic	1	0
Incomplete flaccid	3	2
Total	35	21

TABLE XI
Time between Injury and First Diagnosis
of Complications

Time after injury	Hydronephrosis	Reflux	Stones
Less than 3 months	0	2	0
3 to 6 months	6	8	0
Over 6 to 12 months	11	5	2 (1 bladder)
Over 1 to 2 years	6	3	3
Over 2 to 3 years	6	1	3 (1 bladder)
Over 3 to 4 years	3	0	
Over 4 to 5 years	2	1	
Over 5 to 6 years	1	1	2
Over 6 to 7 years			1 (1 bladder)
Total	35	21	11 (3 bladder)

Tables VII and VIII show the results of 344 patients—298 males and 46 female—who have had check-ups. The result of the last check-up is given, and, in order to give a true comparison, the results of the same patients on their first discharge are also given. The number of originally infected patients who were sterile at their last check-up and of originally sterile patients who were infected at their last check-up is given in the right-hand column.

Table IX shows the results of follow-up in the males related to neurological lesions and shows that the approximate 7 per cent. fall in sterility between discharge and follow up is more or less evenly distributed amongst the different lesions.

The commonest organisms found in the infected patients were *K. aerogenes*, mixed growth, *Ps. pyocyanea*, *Proteus mirabilis*, *B. coli*, *Providencia*, *Strep. faecalis* and *Serratia*. *Strep. faecalis*, which previously was considered to be non-pathogenic, has been shown to precede infection with other organisms by a few days, and as pure *Strep. faecalis* infection was often associated with pyuria we have included it in the list of pathogens.

COMPLICATIONS

Hydronephrosis. Thirty-five patients (7.4 per cent. including two females) developed hydronephrosis of varying degrees; of these, 14 were unilateral and 21 bilateral. The neurological lesions of these patients is shown in Table X and the time lapse between injury and diagnosis of hydronephrosis is shown in Table XI. Thirteen of these 35 patients had only dilated renal pelves but normal calyces, and of these 6 had sterile urine. 22 patients had frank hydronephrosis, and of these 3 had sterile urine. Three of these 22 had gross hydronephrosis, all were infected. As an example of this group, the following case may be quoted:

K.P. Car Accident 15.11.58 at the age of 23. Complete T11 lesion, flaccid. Urine became infected after four weeks and he has had recurrent infections ever since.

An I.V.P. three months after injury showed a left hydronephrosis of moderate degree (fig. 3A). After 16 months, an I.V.P. demonstrated a dilated renal pelvis with some clubbing of the upper calices on the right and a gross hydronephrosis with impaired secretion on the left (fig. 3B).

Four years after injury, I.V.P. showed gross hydronephrosis on the right and very poor secretion on the left (fig. 3C). Residual urine was now 600 ml. Endoscopic bladder neck resection (Dr. I. I. Walsh) lowered residual to 30 ml. and an I.V.P. one month later showed great improvement. The right renal pelvis was dilated but there was only moderate calyceal hydronephrosis. Secretion on the left had improved (fig. 3D).

Two years after resection there was further improvement. The renal pelvis on the right was still dilated but the calyces were nearly normal (fig. 3E). A control I.V.P. on 21.1.66 (*i.e.* three years after bladder neck resection and over seven years after injury) showed identical findings with Figure 3E, with the exception that the right pelvis was definitely less dilated. Residual urine was nil, there was no protein in the urine and only moderate number of white cells. Blood urea was normal.

This man showed the most severe degree of hydronephrosis we have found so far in this series. An important feature in his case was constipation. Prior to injury it was his habit to have his bowels open only once a week, and following his spinal cord lesion he has had episodes of severe constipation although he usually now has his bowels open on alternate days.

He has been full-time employed since 1959 as an inspector in a Government-controlled instrument factory for aircraft. His absenteeism from work is negligible.

Of the nine cases of hydronephrosis with sterile urine, eight have been followed up and five have shown spontaneous improvement, three are unchanged, and one has deteriorated. The latter, who developed a high residual urine and left hydronephrosis, may be described in detail:

R.H. Aged 22. Motor-cycle accident, 10.11.61, head injury and fracture dislocation C5/6 causing tetraplegia complete below C6.



FIG. 3A



FIG. 3B

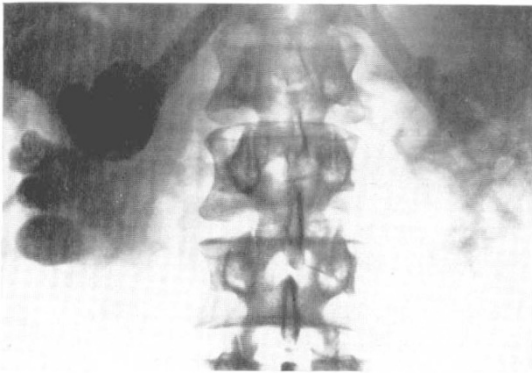


FIG. 3C

Figure 3A—Patient K.P. Three months after injury. I.V.P. shows moderate left hydronephrosis. Figure 3B—K.P. sixteen months after injury. I.V.P. shows a dilated renal pelvis with clubbing of upper calyces on right side and gross hydronephrosis with impaired secretion on the left.

Figure 3C—K.P. four years after injury. I.V.P. shows gross hydronephrosis on the right and very little secretion on the left. (Residual urine 600 mls.)

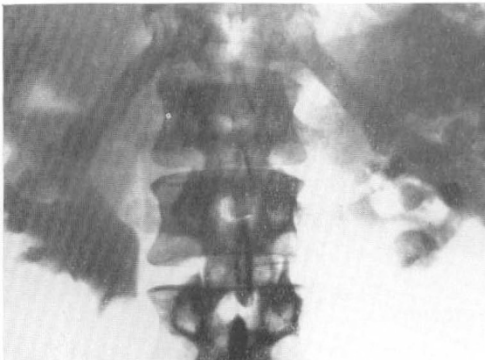


FIG. 3D

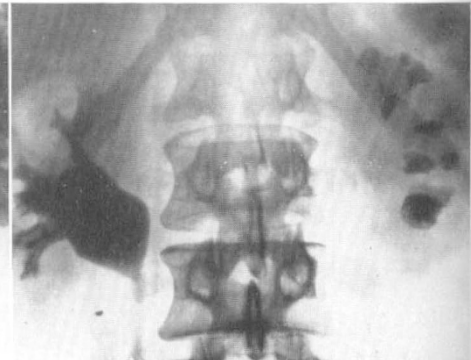


FIG. 3E

Figure 3D—K.P. One month after endoscopic resection of bladder neck which reduced the residual urine to 30 ml. I.V.P. shows lessening of hydronephrosis on the right and improved secretion on the left. Figure 3E—K.P. Two years after bladder neck resection I.V.P. shows that the right renal pelvis is still dilated but the calyces are nearly normal, secretion on the left has improved further.

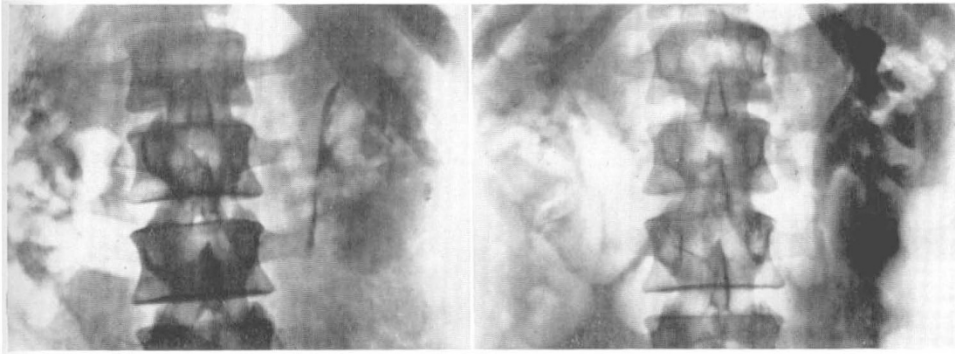


FIG. 4A

FIG. 4B

Figure 4A—Patient R. H. Fifteen months after injury (urine had always been sterile). I.V.P.—normal. Figure 4B—R. H. Three years after injury, urine still sterile. I.V.P. Left mild caliceal hydronephrosis.

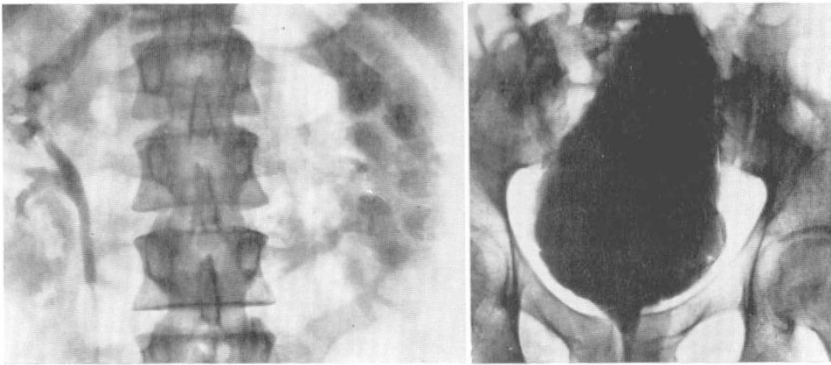


FIG. 4C

FIG. 4D

Figure 4C—R. H. Six months after bladder resection urine now infected. I.V.P. worsening of left hydronephrosis. Figure 4D—R. H. Three years after injury. Cystogram shows irregular pear-shaped bladder. No vesico-ureteric reflux.

First passed urine after four weeks, intermittent catheterisation stopped after eight weeks, residual 60 ml. Urine always sterile for first three years after injury. I.V.P. normal seven months and 15 months after injury (fig. 4A).

At routine check-up three years after injury urine was still sterile but left hydronephrosis of moderate degree was found, consisting of slight bulging of pelvis and some clubbing of calyces (fig. 4B). It may be noted that this although mild was the highest degree of hydronephrotic change found in our cases with permanently sterile urine. The residual urine was checked and found to be 600 ml.; a cystogram showed an irregular pear-shaped bladder but no vesico-ureteric reflux (fig. 4D).

A bladder neck resection was performed and the residual urine reduced to 180 ml. but the urine was now infected and antibiotics produced only temporary cure of the infection.

Six months later (three and a half years after injury) he had recurrent infection and haematuria. Another I.V.P. (fig. 4C) showed markedly increased hydronephrosis on the left (cannon-ball type of calyces), and the residual urine had increased to 450 ml. Another

cystogram showed an irregular bladder outline but again no reflux. The Creatinine clearance was 90.5 ml./min. A further endoscopic resection of the bladder neck was performed and the residual urine was reduced to 30 ml. but the hydronephrosis on the left side remained unchanged.

A review of this case at the end of January 1966 showed no change of the hydronephrosis. The urine was infected with pyocyanea, pus cells 56, protein 111 mg. Blood urea 21 mg. per cent.

Comment. This tetraplegic, whose bladder was always sterile, developed a mild unilateral hydronephrosis about three years after injury. In view of the large residual urine a bladder neck resection was carried out to relieve the back pressure. This operation while eliminating the residual urine was otherwise unsuccessful as it resulted in infection of the urinary tract and further increase of hydronephrosis.

Apart from the two patients with hydronephrosis already described in detail, another four patients with hydronephrosis had high residual urine. All these cases were infected. Six patients with infection of the urinary tract resulting in hydronephrosis had ureteric reflux; four were treated with antibiotics and an indwelling Foley catheter and of these two improved and two remained unchanged. Two patients were treated with antibiotics only; one improved (he later had a normal I.V.P. and cystogram) while the other remained unchanged. Six infected patients had high residual urines, in three the I.V.P. returned to normal after endoscopic bladder neck resections; the other three were treated with Foley catheters resulting in improvement in two.

Three of the patients with hydronephrosis were found to have ureteric strictures one, three and five years after injury and were treated by ureterolysis with considerable improvement, but a certain degree of hydronephrosis persisted in all three.

In the remaining 11 patients, no cause for the hydronephrosis was found other than infection. Six were treated with antibiotics and indwelling Foley catheters with improvement in two. The remaining five were treated with antibiotics alone, with improvement in two.

Vesico-Ureteric Reflux. Twenty-one patients (4.4 per cent.) including two females were shown to have ureteric reflux, 15 were unilateral and six bilateral. Their neurological lesions and time lapse between injury and diagnosis are also shown in Tables X and XI. All these patients had been infected before cystogram at which reflux was demonstrated.

Six patients with reflux and hydronephrosis have been described in the preceding section. Of the remaining 15 patients, four were treated successfully with antibiotics and had normal cystogram and I.V.P. later. One patient was treated with a temporary Foley catheter and 10 were treated with a permanent indwelling Foley catheter, and of these five subsequently had cystograms without reflux but the indwelling catheter was retained.

Diverticula of Bladder. Most of the patients did not have cystograms, but, of those who did, 12 (2 sterile) showed the appearance of diverticulosis or trabeculation and a further 80 (six sterile) had only slightly irregular bladder outlines.

Renal Stones. Eight patients (1.7 per cent.) including two females developed renal stones, three bilateral, five unilateral. The time lapse between injury and

diagnosis of the stones is shown in Table XI. All these patients had had severe urinary infection before the stones were diagnosed. All eight patients had the stones removed surgically (Dr. Walsh). In three patients there has been no recurrence, in five patients the stones recurred and further removal was attempted in three: in two of these the stones have recurred and the third has not yet had the first post-operative check-up. One of the patients with recurrent renal stones is now uraemic and another one has died (the only late renal death in this series so far). He was a 44-year-old man with a T11 lesion admitted nine days after injury with an indwelling Foley catheter and a severe urinary infection; when this infection had been controlled attempts were made to withdraw the indwelling catheter, but each attempt produced a severe urinary flare-up and he was left with an indwelling Foley catheter. Two years later he developed bilateral renal calculi which were operated upon, but he afterwards developed bilateral ureteric strictures and recurrent calculi and died three years after injury.

Bladder Stones. Three patients (0.6 per cent.), two male, one, female developed bladder stones, two while being treated with Foley catheters: their stones were removed at cystoscopy. The remaining patient had his stone removed by open operation. This outstandingly low incidence of calculosis in bladder and kidneys compares most favourably with the 22.5 per cent of calculosis amongst 351 patients of World War II reported by Guttman (1953) and other authors with even higher percentages of calculosis in paraplegics varying between 29-42 per cent.

Urethral Fistulae and Urethral Diverticula. No patient, sterile or infected, developed a urethral fistula.

One patient, who developed a urinary flare-up within two weeks of injury and was then treated with a Foley catheter, had a shallow urethral diverticulum demonstrated by a urethrogram three months after injury.

Vesico-Vaginal Fistulae. This complication was not found in any patient—sterile or infected.

DISCUSSION

The outstanding feature of this 11-year study on the immediate and early management of the paralysed bladder is the fact that intermittent catheterisation with the 'non-touch' method has proved highly effective in preventing and overcoming bladder infection in paraplegics as well as tetraplegics. Since this method was originally advocated during and after World War II by one of us (Guttman, 1947, 1953) as effective in the immediate stage following paraplegia, further experience has shown beyond all shadow of doubt that the majority of paralysed bladders can be kept sterile throughout the whole period that catheterisation is needed. Moreover, it may be noted that in a large number of patients admitted in the early days following injury with already infected bladders as a result of immediate permanent indwelling catheter drainage, intermittent catheterisation replaced this form of drainage and succeeded in rendering the urine sterile and the patient catheter free. On account of the results described in this paper it can now be said categorically that, by proper application of intermittent catheterisation in the immediate and early management of patients with spinal injuries, the ravages

or urinary tract infection, considered throughout the centuries as the main cause of early death and chronic invalidism of these patients, can be brought under control to a degree which no other method so far described in the world literature can approach let alone surpass.

Complications have been remarkably few and most of them occurred in patients with chronic urinary infection. This applies as much to the incidence of vesico-ureteric reflux as to hydronephrosis, diverticulosis and calculosis. Hydro-nephrosis developed in 35 patients (7.4 per cent.) only, and there was a significant improvement in almost 50 per cent, of these following treatment.

Vesico-ureteric reflux occurred in 21 patients (4.4 per cent.), all of whom had been infected before reflux was diagnosed. Neither reflux nor hydronephrosis was related to any particular level or type of spinal cord lesion. This is in accordance with the observations of Guttman (1963), although we have in the present series a higher proportion of reflux in the infected cases within the first 12 months as compared with the result report in that publication. Five of all these patients were successfully treated by antibiotics, as the reflux was detected at an early stage. The majority of patients with reflux were treated by indwelling catheter, as attempts to discontinue permanent drainage caused urinary flare-ups. For some years it has been our custom to train such patients in self-catheterisation with the 'non-touch' technique, in which they are assisted by members of their family. This was found to be more satisfactory than catheterisation performed by unskilled medical or nursing attendants.

Renal stones during the 11-year period were rare (1.7 per cent.) and bladder stones even more rare (0.6 per cent.) indeed an amazing improvement as compared with previous statistics as compiled by Guttman (1953).

Above all, in spite of the many thousands of intermittent catheterisations performed in this large number of patients during the many years of study, there has been not a single case of urethral, peno-, scrotal- or vesico-vaginal fistula. For the sake of the paralysed patients, this achievement alone, apart from the other satisfactory results obtained, justifies the amount of effort expended on this form of management of the paralysed bladder in the early stages following spinal cord injury. Moreover, the amount of money spent on equipment and personnel for intermittent catheterisation at this early stage of bladder paralysis is more than compensated for by the avoidance of prolonged or permanent hospitalisation later for treatment of costly complications developing as a result of inadequate management of the paralysed bladder in the early stages. Thus, by proper initial treatment of the paralysed bladder much misery and chronic invalidism of these patients can be greatly minimised or altogether prevented.

The reasons may be discussed why our results in female patients have been less favourable than in the male. There are several possible explanations for the higher incidence of infection in females:

1. Anatomically the development of ascending urethral infection is easier in the female than in the male. Moreover, some may have been infected before injury. Only recently a female patient with non-traumatic paraplegia was admitted (not included in this series) a short time after the onset of paraplegia, and the cystogram showed a grossly cretated bladder obviously resulting from long standing chronic infection before her paraplegia.

2. The preparation for catheterisation in the female is more difficult, again on account of the female anatomy.

3. As pointed out before, in all male paraplegics intermittent catheterisation was universally performed by the medical officers, while in the female catheterisation was allowed to be carried out by the nursing staff. It has now been decided that the medical officer should also perform the intermittent catheterisation in the early stages in female paraplegics and it will be seen whether results will improve.

4. In some cases, intermittent catheterisation was abandoned in favour of a temporary indwelling catheter when an automatic bladder developed before the patient was able to get up and the bed was wetted between catheterisations. Even then, indwelling catheters were used in such patients only when the urine was infected, but the presence of the catheter prevented rapid and complete eradication of the infection. On the other hand, although the number of female paraplegics is yet too small to assess whether a higher rate of infection will be reflected in later complications, it is interesting to note from our results that more women became sterile during follow-up than became infected.

Many urologists and other workers in this field in this and other countries, especially U.S.A., still reject intermittent catheterisation as harmful in the early management of the paralysed bladder or decline to use it for other reasons, such as lack of time, staff, facilities, etc. One of the most outspoken opponents of intermittent catheterisation has been Prather from the U.S.A., who only seven years ago (1959) in reviewing the experiences during World War II in the United States armed forces, made the sweeping conclusion that 'a programme of intermittent catheterisation is certain to lead to disaster'. One year later Cosbie Ross (1960) of Liverpool stated: 'Both on logical and practical grounds it is obvious that this particular method is not likely to succeed except as a temporary measure.' Our results presented here on a large material have not only exposed the fallacy of these arguments but in fact have proved the outstanding superiority of proper intermittent catheterisation as the method of choice in the management of the initial and early stages of paraplegia and tetraplegia, as compared with any other method described so far. It may be stressed that, since this 11-years study has been completed, further experiences made on an even larger clinical material have confirmed all the findings presented in this paper.

From all this, it is obvious how emphatically we share the strong criticism which has already been expressed on the revival by Blocksom, Lapidès and others of suprapubic cystostomy in the form of what is called cutaneous vesicostomy and which Lapidès (1964) employs as a 'standard treatment in paraplegics within a week or two after injury'. We cannot but dissociate ourselves emphatically from such an approach, which ignores so profoundly the natural forces of physiological adjustment in the spinal man. In our opinion this procedure is a grave mistake and represents a serious retrograde step in the early management of paraplegics and tetraplegics as it adds local damage to the bladder wall in addition to the neurogenic lesion of the bladder. It will result in most, if not all, of the unhappy consequences of suprapubic cystostomy of 25 years ago and it will create a very serious situation if this surgical procedure is followed up by other workers with only little experience in the field of paraplegia and tetraplegia. In this connection the reports published by Krahn *et al.* (1964) and Laskowski and Brantley Scott (1965) are highly significant. One can only hope, therefore, that this procedure will be widely condemned by urologists and other workers concerned with the treatment and rehabilitation of the paralysed, including those who still adhere to the method of immediate urethral drainage by indwelling catheter.

SUMMARY

This paper deals with the management of the paralysed bladder during an 11-year period in 476 traumatic paraplegics and tetraplegics—409 male and 67 female—who were admitted to Stoke Mandeville within the first 14 days, most of them within the first 48 hours, after injury. The patients were followed up after discharge from the Centre at least yearly but often more frequently.

In 370 patients, the urine was sterile on admission ; of these 278 had either intermittent catheterisation (174) or no catheterisation (104) before admission. One hundred and six patients were infected on admission, the majority of them following previous indwelling catheter drainage by Foley catheters (81).

The method of choice employed at Stoke Mandeville in the management of the paralysed bladder was the non-touch technique of intermittent catheterisation (Guttmann, 1949, 1953). This method has proved highly effective in preventing infection of the paralysed bladder, especially in male patients where the catheterisation was carried out exclusively by the medical officer in charge of the case. 64.8 per cent. male and 49.3 per cent. female patients (62.2 per cent. of the total of the 476 patients) had sterile urine on discharge from hospital. 70.4 per cent. of the 186 incomplete lesions and 56.9 per cent. of the 290 complete lesions were sterile on discharge.

Details of late complications are given and attention is drawn to the low incidence of hydronephrosis, vesico-ureteric reflux and calculosis, and in particular to the complete absence of urethral fistulae in patients with sterile or infected urine.

The non-touch technique of intermittent catheterisation has proved superior to any other form of early management of the paralysed bladder hitherto described and has disproved the prejudice held against intermittent catheterisation for so many years by urologists and other workers in the field of spinal paraplegia.

RÉSUMÉ

Le sujet de cet article est le traitement de la paralysie vésicale, sur une période de onze ans, appliqué à 476 paraplégiques et tétraplégiques, d'origine traumatique, (409 hommes et 67 femmes) admis au Centre de Stoke Mandeville pendant les premiers 14 jours après la lésion, la plupart dans les premières 48 heures. Les malades ont été suivis, après leur sortie du Centre, au moins une fois par an, si ce n'est plus.

Chez 370 malades, l'urine était stérile au moment de l'admission, 278 de ceux-ci avaient été traités soit par sondage intermittent (174), ou n'avaient été sondés avant l'admission (104). 106 malades étaient infectés à l'admission, la plupart ayant été traité par sonde à demeure (81). La méthode de choix, employée à Stoke Mandeville dans le traitement de la paralysie vésicale a été celui de la technique dite du 'non-touch' et sondage intermittent (Guttmann 1949, 1953). On a prouvé qu'elle était très effective dans la prévention de l'infection de la vessie paralysée, surtout chez l'homme où le sondage a été pratiqué exclusivement par le médecin responsable du malade. 64,8 % des hommes et 49,3 % des femmes (62,2 % du total des 476 malades) avaient des urines stériles au moment de leur sortie de l'hôpital (70,4 % des 186 lésions incomplètes et 56,9 % des 290 lésions complètes).

Des détails concernant les complications ultérieures sont donnés, et il est rappelé que l'incidence d'hydro-néphrose, de reflux vésico-urétéral et de lithiase a été particulièrement basse chez les malades traités par cette méthode. On peut noter, en particulier, une absence complète de fistule uréthrale chez ces malades avec, ou sans, urines stériles.

La technique du sondage intermittent par la méthode du 'non-touch' s'est avérée supérieure à toutes les autres formes de traitement de la paralysie vésicale jusqu'à présent décrites, et désapprouve le préjudice jusqu'à présent observé par les urologues et autres auteurs, contre celle-ci pendant tant d'années, dans le traitement de la paraplégie spinale.

ZUSAMMENFASSUNG

Es wird über eine 11 Jahre lange Studie berichtet, welche die Behandlung der gelähmten Blase bei 476 traumatischen Paraplegikern und Tetraplegikern betrifft—409 Männer und 67 Frauen—die innerhalb der ersten 14 Tage, die meisten innerhalb von 48 Stunden, nach dem Unfall in Stoke Mandeville eingeliefert worden waren.

Die Patienten wurden nach der Entlassung aus dem Zentrum mindestens einmal jährlich, oft aber häufiger nachuntersucht.

370 Patienten hatten bei der Aufnahme eine sterile Blase. Hiervon hatten 278 entweder intermittente Katheterisierung (174) oder keine Katheterisierung (104) vor der Aufnahme. 106 Patienten waren vor der Aufnahme infiziert, die Mehrzahl (81) von ihnen durch vorherige Dauerdrainage mittels Foley Katheter.

Die Methode der Wahl in der Frühbehandlung der gelähmten Blase war in Stoke Mandeville die 'Non-touch' Technik der intermittierenden Katheterisierung. (Guttman 1949, 1953). Diese Methode erwies sich höchst effektiv in der Verhütung der Infektion der gelähmten Blase ganz besonders bei männlichen Patienten, bei denen die Katheterisierung exklusiv vom behandelnden Arzt ausgeführt wurde. 64·8 männliche und 49·3 % weibliche Patienten d.h. 62·2 % aller 476 Fälle, hatten eine sterile Blase bei der Entlassung vom Hospital. 70·4 % der 186 Patienten mit inkompletten Rückenmarksläsionen und 56·9 % von den 290 kompletten Läsionen waren bei der Entlassung steril.

Einzelheiten über Spätkomplikationen werden berichtet, wobei besonders das geringe Auftreten von Hydronephrose, vesiko-urethralem Reflux und von Steinbildung betont wird. Vor allem wird auf das völlige Fehlen von urethraler Fistelbildung bei den Patienten mit sterilem wie infiziertem Urin hingewiesen.

Die 'Non-touch' Technik der intermittierenden Katheterisierung hat somit ihre Überlegenheit über jede bisher beschriebene Methode der Frühbehandlung der gelähmten Blase bewiesen und hat das Vorurteil widerlegt, das so viele Jahre hindurch Urologen und andere Ärzte hatten, die sich mit der Behandlung von Paraplegikern beschäftigt haben.

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