ENEURESIS

IN

CHILDREN.

Thomson Memorial Medal
in Child Life and Health
1933.
The subject of this essay is enuresis which may here be defined as the unintentional or involuntary passage of urine. As will be shown it is a symptom present in many conditions. Its importance cannot be over-emphasized since it is extremely common, and a cause of much mental and physical discomfort and distress to the child, and embarrassment to the parents. If it occurs during sleep it is termed "eneuresis nocturna;" if occurring when awake "eneuresis diurna," and if a combination of both, "eneuresis continua."

I propose to review briefly the literature on the subject, to discuss the physiology of micturition, and to present the results of an investigation of a number of cases seen at the Urological Department of the Royal Hospital for Sick Children.

Literature.

Much has been written on the subject and many theories advanced but the condition to-day still remains a vexing problem.

The condition is an exceeding common accompaniment of mental defect in children. Burnet (3) claims that certain
types may be a manifestation of epilepsy. Some cases are definitely hereditary in their predisposition. T.K. Monro observed a father, five daughters and one son who all suffered from the condition (15).

Herrman (9) and Wachenheim (19) hold that many cases come under the same category as the tics and habit spasms.

Malnutrition has been cited as a factor, but many instances occur in well nourished children.

Both hypo and hyperthyroidism have been blamed but with no very definite evidence.

A considerable body of opinion regards the condition as a disorder of mental development or of higher cerebral function. Hamill, for instance, declares that enuresis is entirely a volitional condition, and with the will to control urination, the child remains continent.

On the other hand it is clear that it may certainly occur without any other evidence of such a disorder.

Other theories include as causes, constitutional inferiority, exhibitionism, fear of the dark, laziness, profound sleep, etc.

Its association with an enormous variety of minor physical abnormalities has led to a widespread belief that it is of reflex origin. Among the causes cited are, - A long, tight or adherent prepuce, balanitis or narrow meatus in the male, vaginitis in the female, intestinal worms, rectal polypi, anal fissure, kidney disease or organic nervous disease. Even
tonsils and adenoids are reckoned to be factors in some cases.

Some authorities consider it in the nature of a neuritis of the vesical nerves.

It is important to note that many of the conditions which are presumed to give rise to enuresis reflexly, affect the pelvic organs.

I will omit for the present any detailed consideration of treatment that has been adopted in the past, and will proceed to give an account of recent views on the physiology of micturition.

**Physiology and Anatomy of the Nerves of the Bladder.**

The above have been the subjects of recent papers by Learmonth (12) and others.

The bladder receives sympathetic, parasympathetic and somatic nerves. The somatic nerves arise from the 3rd and 4th Sacral segments, forming the pudics which supply the posterior urethra and control the external sphincter. The sympathetic supply to the bladder, and in fact to all the pelvic viscera passes through the presacral nerve.

The lateral roots of this nerve come from fibres in association with the superior mesenteric artery, the coeliac ganglion and the peri arterial renal plexuses. The middle
root forms wide connections through the inter mesenteric plexus with the coeliac, semilunar and aortico-renal plexuses. Near the termination of the presacral nerve branches are given to the lower end of both ureters (20). The intimate nervous connections are important for perfect co-ordination in urinary excretion, while through the lateral roots of the presacral nerve the physiological activities of each kidney are related. The parasympathetic fibres come from the anterior primary divisions of the 2nd and 3rd Sacral nerves and pass to the hypogastric ganglia.

**Impulses carried by nerves of Bladder.**

1. Sympathetic and parasympathetic both contain afferent fibres which convey impulses giving information of the degree of distension of the musculature of the bladder.

2. The sympathetic and parasympathetic both contain afferent fibres conveying impulses set up by painful sensations in the bladder. The pain of spasmodic contraction is carried by the sympathetic, whereas tactile and painful stimuli are carried by the parasympathetic. Some of the sensory nerves of the posterior urethra also pass by the parasympathetic pathway.

3. The parasympathetic contain afferent fibres conveying impressions of tactile and thermal sensibility. A few round the bladder neck may be conveyed by the sympathetic.
4. The parasympathetic contain the afferent fibres concerned in the micturition reflex.

**Efferent Fibres.**

(1) Motor to detrusor muscles supplied by parasympathetic.
(2) Motor to ureteral orifices supplied by sympathetic.
(3) Motor to trigonal muscle supplied by sympathetic.
(4) Motor to internal sphincter supplied by sympathetic.
(5) Inhibitory fibres to detrusor, carried by sympathetic.
(6) Inhibitory fibres to internal sphincter carried by parasympathetic.
(7) Vaso constrictor fibres carried by sympathetic.

**Segments of Cord concerned with Vesical Supply.**

The 2nd and 3rd segments are the ones associated with the parasympathetic pathway to the bladder.

The afferent fibres of the sympathetic reach up to the 9th Thoracic and down to the 4th Lumbar segments.

**Postural Activity in the Bladder.**

This is a most important factor in the physiology of bladder function, and has been described by Wright (21).

The investigations of Mosso and Pellacani demonstrated that the bladder wall adapts itself to its content, so that the internal pressure is always the same. As urine enters
the bladder from the ureters, the bladder fibres elongate, increase the capacity of the bladder, and prevent any rise of internal pressure. In the same way as the bladder empties the fibres shorten. The posture of the bladder is therefore adapted to maintain the same tension with varying amounts of urine. The detrusor muscle also shows similar postural activity or tone.

The internal vesical sphincter possesses an inherent tone, which depends to a great extent on the integrity of the parasympathetic reflex. The sympathetic reinforces the closure of the sphincter. Opening of the sphincter is carried out by inhibition of the natural tonus through the parasympathetic, and is reinforced by contraction of the trigonal fibres which have their origin in the trigone and their insertion in the verumontanum (22).

Micturition.

With proper training a child may be able to control its urine by the age of 10 months. After it has passed the age of two years any involuntary micturition must be considered pathological. This time is necessary for the higher centres of the brain to assume control of the function of micturition.

For the act of micturition only the parasympathetic
pathway is essential. Under normal conditions the adaptation of the bladder to its increasing content is probably carried out reflexly. Afferent impulses pass to the spinal cord and efferent sympathetic impulses from the lumbar segments cause the bladder walls to relax, thus lowering the internal pressure, while the closure of the sphincter is reinforced. The spinal cord possesses the power of regulating the behaviour of the bladder up to a point, without any interference from the cortical centres.

When the content exceeds this limit, the pressure in the bladder begins to rise, as the fibres are increasingly stretched. When the pressure reaches 18 cms. of water, afferent impulses reach the higher centres and the "desire to micturate" results (21). If it is inconvenient to micturate then, impulses from the cerebral cortex act through the sympathetic nerves and further relax the bladder wall and the internal pressure falls. Afferent impulses then cease and the desire passes off.

Micturition can be carried out (1) on the "desire to micturate" or (2) it may be "voluntary." In the latter, the act is carried out without the local desire, or, in other words, without the necessary degree of distension.

In the act of micturition the internal sphincter is voluntarily relaxed and the detrusor muscle automatically
contracts. There is a backward movement of the posterior segment of the internal meatus and of the floor of the posterior urethra, so that the planes of the trigone and the urethra are in alignment. This is brought about by contraction of the trigonal fibres which pass to the verumontanum.

As the parasympathetic is the essential pathway, the spinal centre is in the 2nd, 3rd or 4th Sacral segments. In infancy the act is a pure reflex, later it is subjugated by cerebral influences.

In young children postural activity in the bladder is less perfect than in adults and quite small quantities of urine may raise the pressure sufficient to send up afferent impulses to the cord. The higher centres are not consulted and micturition occurs entirely reflexly. Posture in the bladder may be influenced by many circumstances, e.g. emotion, local irritation, inflammation, etc., or it may be affected reflexly by phenomena in other viscera which have a similar segmental nerve supply.

Eneuresis can be caused in many ways but from the point of view of the nervous mechanism of micturition, all can be grouped into 4 types:-

(1) Interference with inhibitory impulses from cerebrum.

There is lack of development of control or inhibition
from the higher centres. Normally this should be present about the 2nd year.

(2) Afferent stimuli from the bladder may be so powerful that the cerebral inhibition is not sufficient to control it, e.g. by hyperacid urine, calculus, etc.

(3) Hyperirritability of the spinal centres themselves. Only a mild degree of distension produces an excessive excitability of the cord centres which act before the cortical centres can interfere. This may occur in lesions of pelvic organs with a similar segmental supply.

(4) Lack of co-ordination of sympathetic and parasympathetic systems, including all types of "neurogenic bladders," i.e. cases of neurogenic vesical dysfunction.

The efferent fibres are at fault. There may be overaction or weakness of varying degrees of either the parasympathetic or sympathetic. On the other hand, there may be maldevelopment of one or other divisions of the autonomic system, usually associated with maldevelopment of part of the bladder musculature.

From a consideration of the foregoing a classification of enuresis by its causes may be given.
Clinical Classification.

(1) Cases associated with causes outside the Genito-Urinary System.

(2) " " " pathology within the Genito-Urinary System.

Causes outside the Urinary Tract.

(a) Fault in higher cerebral centres.

(b) Reflex causes.

Fault in Higher Centres.

The general intelligence of the patient may be below normal or there may be definite mental deficiency. On the other hand, the higher centres of control may be imperfectly developed from lack of training or bad social environment. In others again, the control centres may be normally developed but become abolished due to the profound sleep of some children.

Excessive masturbation has also been cited as a cause. There is no doubt it may exaggerate any pre-existing lesion.

Laziness by some is regarded as an important factor but again it may be classed as lack of will-power or lack of training.

Heredity of course is important, especially when a neurotic tendency is present.
Reflex Causes.

These are numerous and many have already been quoted. Tonsils and adenoids, digestive disturbances, etc., have been picked out as a probable source of the trouble. Possibly some of them may set up visceral reflexes through the widespread nervous communications of the urinary system.

Faulty dietary may on the other hand act through changing the urinary reaction in addition to causing a metabolic upset.

Worms and other pelvic lesions, e.g. fissure in ano, appendicitis, constipation, etc., may act through reflexes relayed to the bladder originating through irritation of the spinal centres.

Nevertheless, in many cases in which reflex causes are sought no definitely responsible lesion can be found.

(2) Cases associated with Causes in the Genito-Urinary System.

These comprise the most numerous and important section of the cases.

They can conveniently be dealt with in the following groups, namely, causes in (a) Kidneys, (b) Ureters, (c) Bladder, (d) Urethra.

(a) Kidneys.

The possibility of afferent stimuli arising from any
irritant lesion of the kidney must be appreciated. The renal ganglion forms wide connections with the hypogastric and pelvic plexuses and stimuli can readily be relayed to the bladder.

Eneuresis is known to be associated with any condition occurring in the kidneys in children, e.g. suppuration, tuberculosis, calculus, hydronephrosis and tumours. It is almost impossible to state definitely whether such lesions primarily cause the symptom or whether there is an associated lesion in each case common to the posterior urethra or whether an infected urine is an essential accompaniment. Eneuresis may be a symptom of chronic nephritis or nephrosis. It may also be due to the polyuria of diabetes - mellitus or insipidus.

Apart from removing waste products in solution, one must remember the very important part played by the kidneys in the maintenance of acid-base equilibrium. The haemato-respiratory processes deal with the $\text{CO}_2$ while the kidneys deal with the excretion of all other acid radicles.

Benedict & Nash (2) have shown that a resynthesis of ammonia occurs in the kidney, the amount formed depending on the quantity of strong acid to be excreted. In acidotic conditions an increase of nitrogen appears as ammonia. The diuresis in such conditions is due to the extra base, e.g. Sodium and Potassium from soft tissues bringing water with
them to prevent disturbance of osmotic equilibrium. In alkalosis the urine becomes more alkaline due to the excretion of greater amounts of alkaline phosphates and carbonate.

In metabolism, carbohydrate and fat are completely oxidised to CO₂ and water and give no disturbance of acid-base equilibrium. The oxidation of protein leads to the formation of sulphates and phosphates, so that a high protein diet has an "acid" effect.

Summing up, the kidney therefore plays a most important part in the acid-base equilibrium, the principal functions being:

1. **Excretion of Water.** Tissue water is maintained at a constant level. If dehydration occurs, tissue breakdown becomes excessive, acid metabolitis are formed, and acidosis is produced.

2. **Excretion of excess salts** - acid and alkaline, to maintain the ionic concentration of the plasma and tissues at the normal level.

3. **Production of ammonia** as a sparer of fixed base.

4. **Excretion of bicarbonate** as an acid sparer (8).

The pH value of the urine is therefore liable to be a very variable factor and though so far undetermined may in some instances cause an irritability of an unduly sensitive bladder mucosa and be the primary cause of the enuresis.
(b) **Ureter.**

The importance of the nerve connections of the ureter recently investigated by Wharton (20) would be pointed out. They give ideas of possible pathways of afferent impulses from the ureter to the hypogastric plexus and hence to the bladder.

Lesions of the ureter such as stricture, calculi, ureteritis, hydro-ureter etc., may be accompanied by eneuresis. Here again the importance of infection is difficult to evaluate.

(c) **Bladder.**

Many cases of eneuresis show an inflammation of the bladder as a causal factor. Some authorities do not regard this type as a true eneuresis. Wetting of the bed may be the first symptom of a tuberculous cystitis.

Vesical stone may be a cause, by leading to irritation of the bladder neck and to excessive afferent stimuli from that region. Vesical calculus is frequently associated with infection, in some cases preceding stone formation.

The condition of alkaline encrusted cystitis is important in children. Its chief symptom among others is that of eneuresis. The etiology of this condition is uncertain but it is probably a deficiency disorder or a disturbance of metabolism.
The state of chronic granular lymphoid cystitis described by Dr Morison must also be remembered. This condition is common in adult women, but cases do occur in children, especially girls, with enuresis as the only symptom.

There then follows all the cases of neurogenic vesical dysfunction including spina bifida, abnormal lig. subflavum pressing on the dural sac and lumbar nerves (14 & 7), and some cases of Hirschsprung's Disease. Personal observations will be given later.

In the cases of osseous fusional defects of the spine and in those with abnormal ligaments, there is defective innervation from the parasympathetics and the sympathetics assume control. Much the same may occur in Hirschsprung's Disease where the parasympathetic is intact but there is an apparent overaction of the sympathetic.

(d) Urethra.

Many conditions have been cited as causes in the urethra. They are very important and form a large section. Among those mentioned are:

Anterior Urethra. Phimosis, congenital atresia of the meatus, urethritis, stricture, valves, caruncles, etc.

Posterior Urethra. Congenital Valves, polypi, papillomata, Verumontanitis, prostatitis, stricture, etc.
REVIEW OF TREATMENT.

At this stage, it would be convenient to give a brief general review of treatment of enuresis.

The methods are numerous as they are directed against many causes. No one method is effective in every case. Many of the views on treatment are conflicting and in some instances no reason is offered for the measures taken.

As the methods of treatment are so numerous the same classification as in Causes (1) Outside and (2) Within the Genito-Urinary System will be adopted, or for simplicity (1) "Extrinsic" and (2) "Intrinsic."

1) "Extrinsic" Methods of Treatment.

(a) Directed against faults of Higher Centres. This consists in careful training. Great care should be exercised not to punish the child or make it dread its condition or be excessively ashamed of it. A change of environment is often useful. In training, many methods are adopted. The bladder may be emptied when going to bed and then about midnight. Or the parents may waken the child if the bed is wet regularly at a particular time. Williams & Ruhr (17) have used thyroid in some cases of mental deficiency with good results, while Surralach (18) advises testicular extract. Burnet (3), considering the condition to be an expression of epilepsy,
administered bromides. Luminal is also extensively used, especially in neurotic children.

Herrman (9) regarding the condition as a habit spasm has a special method of re-education. The patients urinate at stated times. The patient passes a little, then stops, passes a little more and so on, till the bladder is empty.

(b) Directed against Reflex Causes. The treatment in such cases is more or less obvious. Before reflex causes are assumed it is wise to eliminate causes inside the genito-urinary system. If not, the search for reflex causes is liable to give rise to indiscriminate and unnecessary operations, the least useful being circumcision.

(2) Treatment Directed against Intrinsic Causes.

In this group a complete urological examination must be made before anything can be attempted.

(a) Kidney. In nephritis or nephrosis the case is treated medically. In pyelitis the case is best treated by repeated drainage of the pelvis of the kidneys followed by argyrol instillations. In tuberculosis the affected kidney must be removed. Calculi and tumours must be removed if present while in hydro nephrosis, the distended pelvis can be gradually decompressed by repeated aspirations, at the same time
treating the causative factor, e.g. stricture of the ureter by dilatations or calculus by removal.

In cases of polyuria, if sugar is present then treatment for diabetes mellitus is instituted by dieting with or without the use of insulin. Radcliffe (16) has had success from the use of takadiastase in glycosuria. If no sugar is present and the polyuria is persistent, then the case should be referred to a neurological surgeon for examination of the pituitary body.

With regard to the variations in urinary reaction much work has still to be done. The water intake should be reduced unless the urine be hyperacid. The last meal should be at 6.30 p.m. and should be "dry." All diets should be limited in carbohydrates while meat should be allowed once per day.

(b) Ureter. The treatment here is directed against the cause. Strictures are dilated, and calculi removed. If hydro-ureter is present, the fluid is regularly drained and its causal factor removed. In ureteritis, argyrol is instilled and any stricture formation also dealt with.

(c) Bladder. Probably on the theory of an irritant vesical musculature, belladonna is frequently used. It is best to push it to the physiological limit as described by
Kerley (11). A 1.500 solution of atropine is used. Liquid extract of ergot has also been tried. Cystitis whether pyogenic or tuberculous is best treated by daily wash outs with Potassium Permanganate followed by argyrol instillations. In the bacillary form or, in other words, in chronic granular lymphoid cystitis, bladder irrigations of Silver Nitrate starting with 1.12,000 soon clear up the condition, increasing the strength of the solution as tolerated. In vesical calculus the stone must be removed.

The cases of alkaline encrusted cystitis are difficult to treat. Bladder irrigations, ketogenic diet, cod liver oil, etc. have all been tried with some success.

The treatment of the neurogenic bladder is also difficult. In cases of spina bifida, the spinal nerve roots are freed and a pre-sacral neurectomy is carried out to allow of free play of the parasympathetics or emptying nerves.

In cases with a displaced or abnormal lig. subflavum, cures are reported by Delbet, Leri (14), and Francois (7) by laminectomy.

At this stage the treatment by lumbar puncture might be mentioned. Allaria (1) carries out a pseudo-lumbar puncture. Cathelin (5) and Albarran noticed that injection of cocaine into the epidural tissues surrounding the cauda equina relieved a woman suffering from grave incontinence of urine. They employed the following technique in eneurasis.
The patient is put in Sim's lateral position, the coccygeal spine is located and a lumbar puncture needle introduced in the middle of a line joining the coccygeal cornua, then passed directly upwards. The meninges should not be perforated. From 5-25 ccs. of normal saline solution at body temperature are then slowly injected. This procedure is reckoned to be almost painless and after it the child can be sent home. If necessary it is repeated in 10 days. This method was also used by Curet (6) and Leitas (13).

Jaboulay's technique (10) is somewhat different. In it a needle is introduced between the coccyx and rectum and 100-200 ccs. of normal saline solution are injected.

(d) Urethra. The treatment is usually obvious on careful urological examination.

Anterior-Urethra. In true phimosis, a dorsal slit is carried out, in congenital atresia of the meatus and in strictures, dilatations, caruncles are cauterised and valves destroyed.

Posterior-Urethra. Valves, polypi and papillomata are removed. Verumontanitis and prostatitis are treated with argyrol instillations, while strictures are dilated with sounds.
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The patient is put in Sim's lateral position, the coccygeal spine is located and a lumbar puncture needle introduced in the middle of a line joining the coccygeal cornua. then passed directly upwards. The meninges should not be perforated. From 5-25 ccs. of normal saline solution at body temperature are then slowly injected. This procedure is reckoned to be almost painless and after it the child can be sent home. If necessary it is repeated in 10 days. This method was also used by Curet (6) and Leitas (13).

Jaboulay's technique (10) is somewhat different. In it a needle is introduced between the coccyx and rectum and 100-200 ccs. of normal saline solution are injected.

(d) Urethra. The treatment is usually obvious on careful urological examination.

Anterior-Urethra. In true phimosis, a dorsal slit is carried out, in congenital atresia of the meatus and in strictures, dilatations, caruncles, are cauterised and valves destroyed.

Posterior-Urethra. Valves, polypi and papillomata are removed. Verumontanitis and prostatitis are treated with argyrol instillations, while strictures are dilated with sounds.
PERSONAL WORK.

During the past 2½ years I have had the pleasure of dealing with 86 children with enuresis at the Urological Department of the Royal Hospital for Sick Children. The cases were under the charge of Mr D.M. Morison, to whom I am indebted for much detail. The author has had the opportunity of examining and treating a considerable proportion of the cases.

Number of Children Examined ...... 86

Sex: Girls 34, Boys 52.

Age Periods.

Under 5 yrs. ...... 31
5-7 yrs. ........... 28
8-10 yrs. ........... 24
11-12 yrs. ........... 3
(Older cases transferred to Deaconess Hospital).

Duration.

Less than 6 months ............... 9
6-12 months ...................... 6
1-3 yrs. ......................... 22
Over 3 yrs. ...................... 5
Since Birth ....................... 41
Not Stated ....................... 3
Symptoms.

Frequency .................................. 41
Urgency ...................................... 4
Hesitancy .................................... 1
Dysuria ....................................... 12
Pyuria ....................................... 9
Loin Pain ..................................... 3
Day Wetting .................................. 10
Night Wetting ................................. 52
Both day and night wetting .............. 24

Tabulation of (1) Causes Outside (Extrinsic), and
(2) Within (Intrinsic) the Genito-Urinary System
with brief indication of treatment adopted.

(1) Extrinsic. (a) Faults in higher centres 1.
            (b) Reflex causes ........  0.

(2) Intrinsic. (a) Causes in Kidney ....  1
            (b) Causes in Ureter ....  4
            (c) Causes in Bladder ... 15
            (d) Causes in Urethra ... 10

(To these must be added 55 cases of uncomplicated
nocturnal enuresis, a term applied to a certain type which
will be described later.)
(1) **Extrinsic Causes.**

It will be noted that only one case was seen. He had a complete urologic examination with negative findings and was referred back to the medical department for instructions regarding training, general hygiene and diet. No definite reflex causes were ever found.

The figures above quoted are therefore not necessarily the proper proportions for a general survey of enuresis. The probability is that many of the extrinsic causes are relieved by the physician while only the intrinsic causes are seen by the urologist.

(2) **Intrinsic Causes.**

(a) **Kidney.** The only kidney case is one of hydronephrosis. The child has been under observation for some months and the pelvis is being periodically decompressed. The causal factor is a stricture of the pelvi ureteral junction. After aspiration argyrol is instilled and the stricture dilated.

(b) **Ureter.** There have been 3 cases of ureteritis with accompanying stricture, and 1 case of hydro ureter with stricture. The trouble in all cases was situated at the lower end of the ureter. The cases have had the strictures dilated with special ureteral bougies and argyrol instilled.
(c) **Bladder**. Under this heading there were 3 cases of chronic granular lymphoid cystitis and 2 cases of cystitis with a mixed infection. All received instillations of argyrol from 2-10%, followed if necessary by bladder irrigations of 1,12,000 Silver Nitrate.

There have been 2 cases of alkaline encrusted cystitis. These have had bladder irrigations of Silver Nitrate, ketogenic diet and large doses of Cod Liver Oil emulsion. Both are still under treatment and at the present moment the enuresis has stopped.

There are also 2 cases of polypi of the bladder neck. These have been fulgerated by diathermy.

Lastly there have been 3 cases of spina bifida and 3 cases of Hirschsprung's Disease or Megacolon. In the former there is defective innervation from the parasympathetic, in the latter there is over action of the sympathetic. The changes in the bladder lead to an overflow incontinence. Diagnosis is carried out by complete urological and neurological examinations with the assistance of X-Ray plates. The bladder changes should correspond to the nerves picked out. In one case of Hirschsprung's Disease the lower ends of the ureters were markedly dilated. In the other 2 cases, however, the bladder picture was negative.
In two of the cases associated with spina bifida there was an almost complete loss of tone of the internal sphincter with the production of what is termed, "funnel neck" of the bladder. In one case there was a saddle anaesthesia of the perineum. In two cases, one of spina bifida and one of Hirschsprung's Disease there was residual urine. Its presence is regarded as a characteristic feature of "cord bladder."

In the cases of Hirschsprung's Disease Mr Dott carried out pre-sacral neurectomies. In the case in which the bladder was affected there was a striking return to normal and the eneuresis cleared up.

The cases of spina bifida have up to the present been treated conservatively.

Cystometry. At this point I would like to mention the subject of cystometry. Though no personal work has been done so far, the method is too important to disregard. It is a useful adjunct in the differentiation of bladder conditions and is described in the following words by M. Campbell (4):

"A small catheter is introduced into the empty bladder and, through a 3-way stopcock, is connected with a graduated reservoir on the one hand and a manometer on the other. Definite volumes of fluid (Pot. Permanganate 1.10,000) are introduced into the bladder (20 ccs. or so at a time) and the intracystic pressure recorded. These volume pressure
readings are transferred to a graph sheet on which a curve is plotted. During the bladder filling process, in which cold solution is used, the bladder sensorium is tested by determination of the point at which the patient has the first desire to urinate, and lastly the point of imperative urination. Only by cystometry can the myogenic and neurogenic balance of the bladder be determined and one can find out whether the vesical condition is due to inflammation, obstruction, sympathetic or parasympathetic unbalance." The author concludes, however, by saying - "Out of 172 cystometric studies, only now and then were the observations of diagnostic aid. A half were normal, a fourth were hypotonic (sympathetic unbalance), and a fourth were hypertonic (parasympathetic unbalance). In many of the latter, however, infection existed." This method may therefore be useful in the elucidation of difficult cases.

(d) Urethra. Out of the 10 cases there was one which had an extreme pin point prepuce. A dorsal slit was performed. There was 1 case of mild urethritis and 2 cases of stricture of the anterior urethra. They received argyrol instillations followed by gradual stretchings with sounds. There was one case of calculus in the posterior urethra. Removal was followed by argyrol instillations to clean up the infection present.
The remaining 5 cases showed polyps on the verumontanum. Three were treated by regular instillations of argyrol followed by dilatations of the posterior urethra by sounds. In two cases the polyps were so marked that fulgeration was necessary.

After all these cases are excluded there is still a large group where the lesion is in the urethra and bladder neck. It is to this type that attention is specially directed. They comprise 55 out of the 86 cases. They show excellent kidney function; nothing abnormal in the urine; ureters are healthy; the bladder walls and ureteral openings are negative.

The anterior urethra is negative for phimosis, congenital atresia of the meatus, urethritis, stricture, valves, caruncles, etc.

The posterior urethra shows no valves, polyps, papillomata, prostatitis, stricture, etc., but there are, however, typical changes of its mucosa extending on to the bladder neck. The pathology as far as one is aware has never been described. As the condition is so common and constant it is now looked upon as a definite entity which responds markedly to treatment. The picture therefore is regarded as one characteristic of uncomplicated nocturnal enuresis and for
clarity a full description of the routine urological examination and findings in such a case will be detailed.

A careful history is taken, then an abdominal and spinal examination carried out. Saddle anaesthesia of the perineum may be found. The lumbar and sacral region of the vertebral column are X-Rayed. Under local or general anaesthesia cystoscopy is carried out. In a child over 6 years frequently only a local is necessary. It is of additional benefit since the child can describe any sensations felt during the examination. If a general anaesthetic is used, "gas and oxygen" is preferred.

Any preputial adhesions, dermatitis or local inflammation, ulcers, etc. are noted. Novocaine 4% (\(\text{\textfrac{3}{10}}\)) is then instilled along the urethral canal and allowed to act before driving it into the bladder by means of a bulb syringe.

The Meatus is then calibrated and examined for strictures, etc. by special bulb sounds.

The Urethra is next examined for strictures and any painful inflammatory areas, valves, etc. The canal is then calibrated and dilated gradually if necessary. For the anterior urethra the bulb sounds are used, while for the post urethra special straight sounds are passed. Tenderness of post urethra makes one suspicious of the condition.

A cysto-urethroscope is then passed to the bladder and a sample of urine taken. Residual urine may be estimated.
It may be here stated, that in almost every case similar to
the one being described, the urine is sterile. It is sent,
however, for complete urinalysis, bacteriological, cytological,
and chemical.

The Bladder capacity is then estimated if the case
is examined under a local anaesthetic. If not, a good
estimate is formed by means of the cystoscopic examination.
The bladder capacity is usually unimpaired.

Bladder Walls. Usually entirely negative. No
increased injections, no calculi, ulcers, tumours, etc.

The Bladder Neck shows a general moderate degree of
contracture. The overlying mucosa shows definite congestion
and oedema. The contour may be smooth and even throughout or
there may be marked irregularities with the formation of
bullae suggesting a bacterial infection. The encroachment
may be most marked on the trigonal aspect, giving the appear-
ance of a typical commencing "median bar" formation seen in
adults. In such cases there is therefore stasis of the lower
urinary tract. If this partial obstruction be present there
is also a hypertrophy of the trigone with increase of the
inter-ureteric ridge. This may lead to an obliquity and
partial obstruction of the lower end of the ureters and
therefore to stasis of the upper urinary tract in addition.
Trigone. Usually shows increased injection, but no hypertrophy or accentuation of the inter-ureteric ridge unless any obstructive phenomenon is present.

Ureteral Openings. Negative as to position and appearance. Ureteral Catheters, size F 4½, passed carefully to each renal pelvis to eliminate, stricture, ureteritis, hydro ureter, calculi, etc. By the use of flexible catheters, in cases such as hydro-nephrosis, the tip of the catheter coils round the inside of the sac and no damage is done. On removing the catheter it assumes the position it occupied in the renal pelvis, giving further assistance in the diagnosis.

In addition, with the ureteral catheter in the renal pelvis, aspiration is carried out to find out if there is any residual. An accurate knowledge of back pressure can thus be obtained. Usually the findings are completely negative in a typical case.

The ureters are then calibrated for strictures by means of ureteral bulb bougies.

Posterior Urethra.

The bladder is emptied and the cystoscope partly withdrawn to examine the posterior urethra.

The entire lining mucosa shows marked granular congestive changes.
The supra montane region shows an apparent elongation while its folds appear thickened and fleshy.

The Verumontanum is enlarged and granular and often deeply injected. The contour is frequently irregular. On the surface little delicate bullae may be seen, and can be made to waft about in the irrigating solution by alternately turning the supply on and off. At times the injection is so marked that small bleeding points may be found. These may even give rise to haematuria.

The infra-montane region may also take part in the granular and oedematous changes.

**TREATMENT.**

(A) A course of daily argyrol instillations, \( \frac{3}{4} \) commencing with 2% and working up to 4%, 6%, 8% and 10% as tolerated.

Argyrol is a compound of silver and is not so readily dissociated or thrown out of solution by proteins and chlorides as is silver nitrate. Nevertheless it is a powerful disinfectant. It helps to quieten and heal up the irritant and congestive bladder neck and posterior urethra.

To give argyrol, first \( \frac{3}{4} \) of 4% novocaine are instilled by the bulb syringe along the urethra to the bladder. This acts as a local anaesthetic and soothes the irritant mucosa. Then the argyrol is instilled.
Every 4th or 5th day, according to patient's susceptibility, sounds are passed carefully, after the argyrol has been instilled, in order to dilate the bladder neck. Sounds are passed till F 18 is tolerated in children in children of 10-12 years.

Following the above, in resistant cases, Silver Nitrate, in strengths of 0.5% working up to 5% as tolerated, is instilled to the posterior urethra. This is done by a special instillator, the solution being accurately instilled to the congested parts. First novocaine is instilled to the urethra in the usual way. The instillator consists of a silver catheter with an obtuse angled bend near the tip. On the convexity of the bend is the opening of the lumen of the catheter. The instrument is passed to the bladder. Novocaine escapes. The instrument is then slowly withdrawn till the novocaine stops dropping from the end. The small opening of the catheter is then situated in the posterior urethra just outside the neck of the bladder. The tip of the instrument is still actually in the bladder. 1-2 ccs. of Silver Nitrate are then instilled along the metal catheter by a record syringe. Silver Nitrate is an irritant disinfectant and helps to tone up the posterior urethra. The silver instillations are carried out once weekly.
(D) If polyps or bullae have been noted and are not relieved by the silver applications, they are best destroyed by diathermic coagulation.

In addition to these measures any local fault must be corrected, e.g. contracted bladder, by regular and gradual distension by fluid through a catheter, or stricture of lower end of ureters, by dilatations with ureteral bulb bougies.

It is of extreme importance that the confidence of the patients be obtained from the first and they must be impressed that they are no different from other girls and boys. By the development of such an attitude the course of treatment is made much more easy and even striking in its simplicity.

Nature of the Lesion. It is difficult to state the exact nature of the lesion. It is definitely not of nerve origin. In cases of Hirschsprung's disease with associated bladder changes, the mucous membrane of the neck and posterior urethra is healthy. These cases are instances of sympathetic overaction. Even after sympathectomy with free play of the parasympathetic there are no changes characteristic of the condition described. In cases of spina bifida with an impaired parasympathetic supply, the mucosa still remains unchanged.
It would appear to be a mild congestive condition or toxic phenomenon. In a few instances there was a recent history of one of the exanthemata, especially diphtheria and measles, the symptom dating from the fever. This factor, however, is not constant. On the other hand it may be an irritative phenomenon either from an irritant urine or from local pelvic reflexes.

The actual nature of the pathology is therefore still uncertain and further work has to be done.

RESULTS OF TREATMENT.

Intrinsic Cases of Eneuresis.

(a) Kidney. In 1 case of hydronephrosis the symptom is relieved.

(b) Ureter. The 4 cases are cured.

(c) The 5 cases of cystitis are cured while the 2 cases of alkaline encrusted cystitis are improved. The 2 cases of polypi of the bladder neck are cured as are the three cases of Hirschsprung's Disease. The 3 cases of spina bifida show slight improvement.

(d) The 10 cases showing causes in the urethra are all relieved from their symptoms.

Out of the 55 cases of uncomplicated nocturnal eneuresis 30 cases show complete relief with treatment. No
case is considered a cure till at least 6 months have passed without bed wetting. Only then can the result be termed permanent. Of the remaining 25 cases, 4 have been lost trace of, while the rest are attending the urological department for treatment. All are making satisfactory progress.

The results of treatment in uncomplicated nocturnal enuresis are therefore very encouraging. Patients differ in the rapidity of their response. Some clear up after one or two dilatations, others have to return regularly for 2-3 months before the condition is relieved. No case has failed to react. Investigation is still to some extent under way and considerable time must elapse before a conclusive opinion can be expressed but at present results indicate that permanent cure can be guaranteed in the great proportion of cases.

SUMMARY.

(1) The subject of the essay is Eneuresis in Children.

(2) Literature on normal and abnormal bladder function has been briefly reviewed in so far as it is related to the subject.

(3) A classification of enuresis has been suggested and principals of treatment are indicated.
An investigation of 86 cases of enuresis in children has been carried out and the results appended. Investigation revealed that in a large proportion of cases the disorder is associated with an abnormal condition of the posterior urethra and bladder neck. A full description of the pathology, method and results of treatment in these cases is given.
# REFERENCES


7. Francois: J. Deux cas de retention complete d'urine due au spina bifida occulta gueris par l'aminectomie. J. d'Urol. 25, 133, 1928

8. Graham & Morris: Acidosis and Alkalosis, p.43 etc.


22. Young & Wesson: Arch. of Surgery, 1921, iii, 1.
Personal Diagrams—

Showing—

1) Innervation of Bladder  
2) Instruments used in Routine Examination and Treatment.  
3) Typical Picture in Normal Case and in Uncomplicated Nocturnal Enuresis.
Sympathetic
Parasympathetic
Somatic

Renal Plexuses.
Celiac Ganglia.
Semilunar Ganglia.

Intermesenteric Plexuses

Presacral Nerve.

Hypogastric Nerves
Pelvic Nerves

Anterior Primary Divisions of Sacral Nerves.

Internal Sphincter.
Posterior Urethra.
External Sphincter.

Afferent Fibres.
Efferent Motor.
Efferent Inhibitory.

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-Innervation of Bladder.-
-Bulb Syringe-

This is used for the instillation of novocaine and argyrol into the urethra and bladder.

-Bulb Sound-

This is used in every case of cystoscopic examination. The meatus and anterior urethra are graduated and any point of undue tenderness elicited.

-Straight Sound-

This is used in every case to graduate the posterior urethra and to find out any unduly sensitive portion. It can also be used for dilating the urethra.
- **Silver Instillator.**

The method of using this instrument for instilling silver nitrate into the posterior urethra has been fully described.

- **Whistle Tipped Ureteral Catheter.**

This type of catheter size F 4½ is used to catheterize the ureters in every case. It has a terminal and two lateral holes.

- **Olivary Tipped Ureteral Catheter.**

This type of catheter is used when the ureteral opening is too small to admit a whistle tip easily, or when there is a stricture of the lower end of the ureter. It has two lateral holes.

- **Ureteral Bulb Bougie.**

This type of catheter is used to calibrate the ureters and to diagnose the presence of strictures and also to dilate them.
1) Neck of normal bladder about 9 o'clock seen through operating cystoscope. The interior of the bladder is illuminated. The margin of the neck is regular and even.

2) Neck of a bladder in a case of uncomplicated nocturnal enuresis about 9 o'clock seen through the operating cystoscope. The interior of the bladder is illuminated. The margin of the neck is irregular and granular.
3) Neck of normal bladder about 6 o'clock seen through a cysto-urethroscope. The bladder neck in this case is illuminated and the interior of the viscous in the shade. The difference between the operating cystoscope and the cystourethroscope lies in the relationship of that part of the sheath with the lamp to the terminal lens of the telescope. Note also the regular and even margin of the neck.

4) Neck of a bladder in a case of uncomplicated nocturnal enuresis about 9 o'clock seen through the cysto-urethroscope. The bladder neck, in this case, is irregular granular and markedly injected.
6) Neck of Bladder in normal case about 6 o'clock trigonar aspect. Seen through operating cystoscope. The interior of the bladder is illuminated.

The margin of the neck is regular and even. The vertical folds can be seen passing down to the verumontanum.

4) Neck of Bladder in case of obstructed nocturnal enuresis. About 6 o'clock seen through an operating cystoscope. Again the interior of the bladder is illuminated.

The contour of the neck is very irregular and heaped up, while the longitudinal folds are exaggerated.
8) Neck of normal bladder about 6 o'clock seen through cystourethroscop. The neck of the bladder is illuminated. The margin of the neck is regular and even. The longitudinal folds can be seen passing down to the verumontanum seen at the bottom of the picture.

9) Neck of bladder in case of uncomplicated nocturnal enuresis seen about 6 o'clock through a cystourethroscop. The neck of the bladder is illuminated. The contour of the neck is very irregular. The mucosa is heated up and markedly injected. The longitudinal folds are very pronounced. There is increase in length of the supra-montane region so that the verumontanum is just seen.
Normal verumontanum seen through the cysto-urethroscope, showing three vertical slits, the utricle in the centre and the ejaculatory ducts on either side on either side of the verumontanum are the lateral sulci and lateral walls.

11.)

The Montane region in a case of uncomplicated nocturnal enuresis seen through the cysto-urethroscopic. Above are the vertical folds of the supramontane region with injected mucosa. The verumontanum shows general enlargement and engorgement while small cystic bullae are present. The sinus prostaticus is markedly injected. The lateral sulci and lateral walls also share in the hyperaemia and show small bullae and small bleeding points.