THE CLASSIFICATION OF ENURESIS

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During the past three years at Whipps Cross Hospital we have investigated 200 children suffering from enuresis. We define this condition as the involuntary voiding of urine by distinct acts of micturition. There are two elements here. The first, that the act is involuntary, may well be governed by psychological factors. But before a bladder will empty it must be filled, so it seemed important to disentangle the mechanical factors which are responsible for filling the bladder. In a previous paper (Poulton, 1952) it was shown that children will not invariably wake in order to empty the bladder should it fill during sleep: they are just as likely to wet the bed. It follows that any child who excretes by night a quantity of urine which is more than the bladder can comfortably contain, is liable to enuresis. We soon found that most of our patients were over-filling the bladder.

Further analysis showed that this imbalance might be due either to anomalous renal excretion, or to defective working of the bladder as a storehouse. Our classification of enuresis, therefore, has three main groups: Anomalies of renal secretion, anomalies of bladder function, and psychological factors. Children found suffering from overt organic disease have been excluded.

Methods of Investigation

Each child was admitted to the ward for a week. During the day the child passed urine whenever he wished, and the volume of each specimen was recorded. During the night the child was awakened every three hours to pass urine, or more frequently if this was found necessary to prevent wetting.

Definitions

Enuresis is defined as the involuntary voiding of urine by distinct acts of micturition.

Day and night periods are regarded as beginning at 8.0 a.m. and at 8.0 p.m.

The mean diurnal and nocturnal excretions are the mean volumes excreted during the day and night periods respectively.

The mean 24-hour excretion is the sum of the mean diurnal and nocturnal excretions.

The day-to-night ratio (D/N) is the ratio between the mean diurnal and the mean nocturnal excretions.

The maximum functional bladder capacity is the greatest volume of urine passed in one act during the period of observation.

The mean functional bladder capacity is the mean of all the volumes passed in separate acts during the day period, i.e. at times chosen by the patient.

The N/B ratio is the ratio between the mean nocturnal excretion and the mean functional bladder capacity. This ratio indicates the number of times the bladder is comfortably filled in an average night under ward conditions.

Normal Values

The normal values have already been given (Poulton, 1952). They are based on the findings in 18 normal children.

The maximum functional bladder capacity in ounces is not less than the age in years.

The mean functional bladder capacity in ounces is not less than half the age in years.

The mean 24-hour excretion does not exceed under ward conditions the figure of twice the age in years plus 18 ounces.

The D/N ratio is greater than 1.8.

The N/B ratio is not greater than 2.0.

Classification of Enuresis

Enuresis Associated with Large Output of Urine at Night. The term 'large' means more than the average person of that age can be expected to hold.

ABSOLUTE POLYURIA. The total volume excreted in the 24 hours is abnormally large, but the proportion of this excreted by day and by night is normal.

RELATIVE NOCTURNAL POLYURIA. The total volume of urine excreted in the 24 hours is normal, but an unduly large proportion of this is excreted at night. Even when the disability appears to have been acquired, there is no evidence of organic disease as usually understood.

RELATIVE NOCTURNAL AND ABSOLUTE POLYURIA. The volume of urine excreted in the 24 hours is abnormally large, and in addition an unduly high proportion of this is excreted at night.

Enuresis Associated with Abnormal Bladder Function

RETARDATION ENURESIS. Voluntary control of micturition is acquired late, and the functional bladder capacity is low considering the age of the patient.

DEFECTIVE BLADDER SENSATION. The functional capacity of the bladder is not greatly below normal, but the bladder is emptied without premonitory sensation of fullness.

ACHALASIA OF THE DETRUSOR MUSCLE. The functional bladder capacity is small, with resulting frequency and precipitancy.

PASSIVE RELAXATION OF THE BLADDER SPHINCTER DURING SLEEP. Only one case was found.

ORGANIC LESIONS OF THE URINARY TRACT affecting bladder function. Such cases are excluded from this series.

Enuresis Due to Impulses from the Higher Centres
PSYCHOGENIC WETTING. Three cases were wet by day and nine cases by night.

ORGANIC CENTRAL ENURESIS. Cases are excluded from this series.

Unclassified Enuresis. There remained some children (15 cases) whom we could not allocate with certainty to any of these headings.

Table 1 summarizes the numbers of each kind of case according to our classification.

TABLE 1
CLASSIFICATION OF 200 CHILDREN SUFFERING FROM ENURESIS

		Boys	Girls	Total
<i>A. Enuresis Associated with a Large Nocturnal Output of Urine</i>				
Absolute polyuria		15	6	21
Relative nocturnal polyuria	Inherited	74	34	108
	Acquired	11	4	15
Relative nocturnal and absolute polyuria	Inherited	6	3	9
	Acquired		1	1
Total		106	48	154
<i>B. Enuresis Associated with Abnormal Bladder Function</i>				
Retardation enuresis		3	2	5
Defective bladder sensation		4	2	6
Achalasia of the detrusor muscle		5	2	7
Passive relaxation of the bladder sphincter			1	1
Total		12	7	19
<i>C. Enuresis of Central Origin</i>				
Psychogenic day-wetting		1	2	3
Psychogenic night-wetting		6	3	9
Total		7	5	12
<i>D. Children not allocated to any category ..</i>				
		9	6	15

The Forms of Enuresis with Illustrative Case Histories

Absolute Polyuria of Functional Origin. Enuretic children were assigned to this category if their 24-hour excretion under ward conditions exceeded twice their age in years plus 18 ounces. The urine was normal chemically and microscopically, and reached a specific gravity exceeding 1.020. These children were excessively thirsty, taking water at least three times between each meal. In consequence they suffered from diurnal frequency and precipitancy. Some were able to limit their drinks to meal times, with great improvement of their symptoms, but many were either unable or unwilling to do this. A family history of bed-wetting was common, but not invariable.

CASE 1. Allen S., aged 7 years, started having nocturnal enuresis at 4½ years and got steadily worse. This was accompanied by increased drinking, especially in the evenings. He now has excessive evening thirst. His uncle is a bed-wetter at 25 years of age. On investigation his urine was normal, and a specific gravity of 1.034 was recorded. His mean excretion in the 24 hours was 40 oz., of which 28.3 oz. was excreted by day, and 11.7 oz. by night. The maximum functional bladder capacity was 8 oz., and the mean was 5.7 oz. Thus, although the volume excreted at night was not an unduly high proportion of the total, it was more than he had ever passed in one act.

Inherited Relative Nocturnal Polyuria. In these children nocturnal enuresis occurs from birth, and from nearly all a family history of bed-wetting can be elicited. In some cases there are relatives who rise repeatedly during the night in order to void urine. On investigation it is found that an unduly high proportion of the urine is excreted during the night. The total 24-hour excretion varies widely, from quite low figures to the upper limit of normal, where this group merges into those cases classified as inherited relative nocturnal and absolute polyuria. Those with large fluid outputs show polydipsia. The functional bladder capacity may be large, but in half the patients it is subnormal. Frequency and precipitancy are present if either the functional bladder capacity is very low, or if the 24-hour urinary output is high.

CASE 2. Sylvia C., aged 9 years, was wet every night from birth, but had been dry by day since 2 years of age. She drank water twice between each two meals, and had precipitancy of micturition but no diurnal frequency. Her maternal aunt had been a bed-wetter up to the age of 14. Her mother, although never wet, has had to rise two or three times nightly all her life in order to void urine.

Her urine contained no albumin or cells, and a specific gravity of 1.024 was recorded. In the ward she passed

a mean volume of 18.7 oz. in 24 hours, of which 11.6 oz. was passed by day, and 7.1 oz. by night. This gives a D/N ratio of 1:6. The greatest volume voided in one act was 6 oz., and the mean was 3.3 oz., indicating a low functional bladder capacity.

She was instructed to void urine at increasing intervals during the day. After two months she voided at four-hourly intervals, and had had a few dry beds. After five months she could hold her water all day, and had no more wet beds.

About half of these children will become dry after such bladder drill alone if this is carried out conscientiously for the long period required. Others will be helped by administering, in addition, ephedrine, belladonna, or amphetamine.

Acquired Relative Nocturnal Polyuria. These children have acquired nocturnal continence at the usual age, but have become wet at night subsequently. There is usually no family history of wetting. In many cases the enuresis dates from an illness or a head injury.

CASE 3. Rodney G., aged 11 years, began to wet the bed at 4½ years of age during an attack of whooping cough. Since then he had been wet every night, except for an occasional period of a few days. There was no history of bed-wetting in the family. In the ward he was found to be excreting an average of 16.1 oz. by night, and only 9.4 oz. by day. His functional bladder capacity was large, the maximum being 15 oz., and the mean 6.9. He was already in the habit of passing his water infrequently by day; after nine months he succeeded in holding his urine for 10 hours, and at this stage was dry for one week in every three. Subsequently he was able to increase this interval to 14 hours, and has been quite dry for the past year.

In this boy earlier treatment with ephedrine and amphetamine had failed.

Inherited Relative Nocturnal and Absolute Polyuria. These patients combine the characteristics of absolute polyuria of functional origin and inherited relative nocturnal polyuria. There is a family history of enuresis. They are excessive drinkers and frequently have abnormally large appetites. They exhibit diurnal frequency and precipitancy. They wet many times each night and are often very resistant to treatment.

CASE 4. Brenda M., aged 6 years, had been wet day and night all her life. Her maternal uncle is a bed-wetter in adult life. A maternal aunt had nocturnal enuresis to 9 years of age. The child's urine was free from albumin and cells, but the highest specific gravity reached was only 1.015. She was found to excrete a mean volume of 33 oz. in 24 hours, 13.1 oz. by night, and 19.9 oz. by day. The D/N ratio therefore was 1:5. The maximum functional bladder capacity was 10 oz., and the mean value 4.1 oz.

Six months later she was dry by day, but even after a

year she was unable to contain her urine for more than three hours by day, and was still wet every night. There was no response to treatment by ephedrine.

Her maternal uncle, William J., was also investigated at the age of 26 years. He had been a bed-wetter all his life. He passed a mean volume of 32 oz. by night, and 27 oz. by day. The maximum functional bladder capacity was 16 oz., and the mean capacity 7.15 oz. Thus his disability closely resembled that of his niece.

Acquired Relative Nocturnal and Absolute Polyuria. The history of these patients resembles that of those with acquired relative nocturnal polyuria.

CASE 5. Pamela C., aged 8 years, had been quite dry by day and night from 2 to 4 years of age. At 4 years of age she was admitted to hospital suffering from meningococcal meningitis. On discharge home she was found to be wetting every night, and was never dry at night afterwards. When investigated she was wetting at least twice every night. The urine was free from cells and albumin, and reached a specific gravity of 1.025. In 24 hours she excreted an average of 43½ oz., of which 27½ oz. were excreted by day, and 16 oz. by night. Her functional bladder capacity was high for her age, but not high enough to contain the urine excreted at night. The maximum figure was 14 oz., and the mean was 9.1 oz.

Treatment was by restricting drinking to meal-times, with no drink in the evening, and by bladder drill. Fifteen months later she was passing urine only three times in the day, and was wet only once every three months.

Retardation Enuresis. In these children control over the excretions is acquired in the usual order of progression, but abnormally late. Sometimes but not always, other milestones are also passed late. The numerous incontinent mental defectives come into this group.

It is suggested that nocturnal enuresis develops in these patients as follows. The voluntary control of micturition is delayed, so that by the time the bladder is able to respond normally to distension, the volume of urine excreted by night is already considerable. The interval before the bladder becomes attuned to holding this large volume is therefore longer than it would be in a less backward child; some in fact never learn to contain this nocturnal excretion. There is only occasionally a family history of bed-wetting; a family history of backwardness is less uncommon.

CASE 6. James K., aged 5 years, with no history of bed-wetting in the family, had always been backward. Although he started to walk at 9 months of age, he was unable to talk properly until between 3 and 3½ years. His control of defaecation was complete at 4½ years, and when seen at 5 years he had just become dry by day. He had never been dry by night.

Defective Bladder Sensation. This causes precipitancy of a very particular kind. There is no premonitory sensation of bladder distension, so that a sudden explosive act of micturition occurs with very little, if any, warning to the patient. The result of this is repeated day wetting. If the functional capacity of the bladder is normal, there may be no frequency, and the child is dry at night. In many patients, however, the functional bladder capacity has remained low, and they also wet at night. These children therefore wet both by day and by night, but they show no nocturnal polyuria.

The defective sensation may lie at the perceptual level rather than in the sensory tracts or end-organs. There is a good response to time training; if the bladder is emptied by the clock at such frequent intervals that it never becomes completely filled, the child quickly becomes dry by day, and subsequently the intervals can be slowly increased until he becomes dry by night.

CASE 7. Robert R., aged 7 years, with no family history of enuresis, suffered from precipitancy of micturition and some frequency. All his life he had been liable to wet in the daytime, because he could not reach the lavatory in time. He was a quiet, intelligent child, and was not backward in development. He had started to use the pot at 18 months of age; he had started to become dry at night at 3 years, but still had occasional wet beds. In the ward the greatest volume passed in one act was $5\frac{1}{2}$ oz., and the mean volume was 3.2 oz. Thus his functional bladder capacity was a little low. There was no nocturnal polyuria; the mean volume excreted at night was 5.75 oz. His chief disability therefore was the brief sensory warning of impending emptying.

Achalasia of the Detrusor Muscle. In children who show this condition the predominant symptoms are excessive diurnal frequency and precipitancy. The precipitancy results, not from any defect of sensory perception, but from failure of the bladder to expand further after the first sensation of fullness is produced. In some this precipitancy results in wetting by day; in others the low functional capacity results in wetting at night, but the volume of urine excreted at night is normal for the age. Frequently day and night wetting are both present; but if the nocturnal excretion of urine is low, these children may be dry at night in spite of the achalasia but wet by day.

A family history of wetting is not uncommon, and relatives may give a history of frequency and precipitancy without wetting.

CASE 8. Maureen P., aged 11 years, had suffered from wetting by day all her life. She had been wet at night also until 6 years of age, but was now quite dry at night, rising once or twice on many nights to void urine. Her mother

had been a day-wetter to 14 years of age, and her father's sister wet by day and night to the same age. She showed marked diurnal frequency, voiding urine, according to her parents, at least every half-hour, and receiving very brief sensory warning of the imminence of micturition. Attempts to hold back her urine voluntarily caused severe pain. She was a bright, intelligent child, rather inclined to tears. She was described as an abnormally large eater, but was not an excessive drinker. Her urine showed no abnormality and reached a specific gravity of 1.040. The mean volumes excreted by night and by day were 5.6 oz. and 16.7 oz. respectively. The greatest volume passed in one act was 7 oz., and the mean volume 3.6 oz. She therefore had a low functional bladder capacity, but a normal excretory rhythm.

She was instructed to void urine every half-hour by the clock, and was then fully continent.

Relaxation of the Bladder Sphincter During Sleep. The symptoms are of wetting at night, but also during the day when the child falls asleep. This symptom may occur in other forms of enuresis in children in whom either the total excretion of urine is large, or in whom the bladder will hold very little urine. Only in the following child was the excretion and storage of urine completely normal.

CASE 9. Maureen L., aged 5 years, with no family history of enuresis, had been wet all her life, wetting every night and by day if asleep.

The urine was normal, and reached a specific gravity of 1.030. The mean 24-hour excretion of urine was 18.35 oz., of which 6.25 oz. were excreted by night, and 12.1 oz. by day. The maximum functional bladder capacity was 9.5 oz., and the mean was 4 oz. Thus there was no mechanical reason for the enuresis, apart from the relaxation of the sphincter during sleep.

Abnormal Bladder Function Resulting from Organic Lesions of the Urinary Tract. This group of cases is discussed in textbooks of urology.

Psychogenic Enuresis. Micturition in normal adults and children is often affected by emotion. Most strong emotions result in frequency. Similarly emotion may greatly increase the frequency and precipitancy which are prominent symptoms in many children with enuresis. In some children, in whom continence of urine has been recently acquired or who are continent by a narrow margin, a strong emotion may cause the functional bladder capacity to fall until enuresis appears.

Polydipsia, and consequent polyuria, may be psychogenically determined. The polydipsia may be due to the thirst caused by the polyuria; it may also be due to a liking for water or other fluids, but in the following child it was one manifestation of an abnormal appetite.

CASE 10. Janet F., aged 5 years, had been wet day and night from birth. She was always at the tap, drinking water as much as four times between each two meals. She had marked diurnal frequency, sometimes voiding urine as often as four times an hour, and marked precipitancy. She was very sore around the vulva from continual dampness. She had suffered from pica from 2 years of age, and still carried about a piece of rag to chew lest she should tear her handkerchief to pieces with her teeth.

She was of average intelligence, and had a very good appetite. Her urine was normal, and reached a specific gravity of 1.020. In hospital she was quite content with the fluids offered in the normal ward routine, and had a mean intake of 27.6 oz. in the 24 hours. In these circumstances she showed no abnormality of urinary excretion or storage.

Enuresis when determined essentially and directly by psychogenic factors is characterized either by a date of onset associated with an environmental change or with variations in severity associated with environmental stresses. It is found that a family history of enuresis is rare in these children. In some there are other psychogenic symptoms, such as encopresis or refusal of the pot.

Psychogenic enuresis may be either purely nocturnal or chiefly diurnal.

Psychogenic Day-wetting. This results from frequency and precipitancy of emotional origin. The functional bladder capacity may be low, but is often found to be normal in ward conditions.

CASE 11. Jean A., aged 7 years, with no family history of enuresis, had become dry by day at 1 year, and dry by night at 18 months of age. However, when she started school at 5 years she started to wet in the daytime. This wetting was associated with marked diurnal frequency (she had to leave the class twice each lesson) and with precipitancy of micturition. These symptoms occurred at school but not while she was at home. She was worried over her work, and not very good at it; she wet more often during the lessons of a teacher whom she feared. More recently occasional night wetting had also occurred.

In the ward her functional bladder capacity and excretory rhythm were quite normal, and she was quite dry. It appears that her enuresis was the result of an over-reaction to the emotions of worry and fear. After adjustments had been made at school, she became entirely symptom-free.

Psychogenic Night-wetting

CASE 13. Janet P., aged 8 years, with no family history of enuresis, was quite dry until 5 years of age. Nocturnal enuresis began when she started school, and from then on she wet every night during the term but never during the holidays. She never wet by day. She was an intelligent girl, and good at her lessons, but she nevertheless greatly disliked school.

Her excretion and storage of urine were quite normal

when investigated in hospital. In this child there were no emotions of worry or fear, but she harboured resentment against her parents for sending her to school.

Organic Central Enuresis. For enuresis secondary to idiopathic epilepsy or to lesions of the central nervous system, textbooks of neurology should be consulted.

Discussion

Familial enuresis due to abnormal rates of renal excretion probably form one group of cases. Those with only relative nocturnal polyuria shade off imperceptibly into those with absolute polyuria and polydipsia in addition. Some children with absolute polyuria alone if they have a family history of enuresis may be included in the same group. In others an abnormal appetite for fluids may be the prime factor. Some children with polydipsia will limit their intake of fluid voluntarily, drinking only at meal-times, but others say they cannot do this because of overwhelming thirst.

The division of children with relative nocturnal polyuria into two groups, in which the condition is inherited and acquired, is based on the following findings.

If all children with a low D/N ratio are considered, whether the 24-hour output is excessive or not, there are 117 children whose symptoms have dated from birth, and 16 children who, according to their parents, had acquired continence at the usual age and become wet later.

Of the 117 children who had never been dry, 92 gave a history of enuresis or of excessive nocturnal micturition in the family, while 17 denied any such history. The family history of eight children was not known, most of these being adopted or deprived children.

Of the 16 children who had begun to wet after continence had once been established, only six gave a family history of enuresis or of excessive nocturnal micturition. In nine children there was no such history, while the family history of one child was not known. In 11 of these children enuresis had been precipitated by a known physical factor (disease or injury), and in eight of these there was no family history of enuresis, while one was the child whose family history was unknown.

There is a marked contrast between the two groups, those never dry, with a strong family history, and those who were dry for a period, becoming wet later on, with no family history. It suggests that there is a real difference between them, and that relative nocturnal polyuria may be acquired.

It will be noticed that the separation between the groups is not complete. There are some children, always wet, who have no family history of enuresis.

It is possible that some physical factor produced a relative nocturnal polyuria before the normal age of becoming dry, so that infantile incontinence passed insensibly into 'acquired' enuresis. There are also six children, who became dry only to relapse later, who have a family history of wetting. Possibly they had overcome their familial disability, when a harmful stimulus caused them to lose control again.

The diseases or injuries which were held to have precipitated nocturnal enuresis in these children were the following: pertussis (one case), scarlet fever with diphtheria (one case), scarlet fever with chicken pox (one case), measles (two cases), concussion (two cases), meningococcal meningitis (one case), poliomyelitis (one case), one case of Mantoux conversion associated with lassitude and fatigue, and one child who had an obscure affection which may from the story have been an encephalitis.

Precipitancy of micturition is a symptom found frequently in enuretics belonging to various groups, often associated with diurnal frequency. It occurs when the interval is short between the initial desire and the overwhelming urge to micturate. It may be due to extremely rapid filling of the bladder, as in those with absolute polyuria, to failure of the bladder to relax further (achalasia of the detrusor muscle, Braithwaite, 1950), or to failure to perceive the initial sensation of bladder distension. Frequently the functional capacity of the bladder is small and the bladder is therefore filled very rapidly; one might expect precipitancy also if the bladder sphincter were weak. It is not always easy to distinguish between those children who fail to perceive when the bladder is full and

those whose bladder will not relax beyond this point. Sometimes, however, the latter say that attempts to hold back their urine result in abdominal pain.

There is no doubt about the reality of psychogenic enuresis. It is not as common, however, at least in a general out-patient clinic, as has sometimes been maintained in the past.

Summary

An analysis of 200 consecutive cases of functional enuresis is described, and a classification based on this analysis is suggested.

In over three-quarters of the children an unusually large quantity of urine was found to be excreted at night, far more in fact than the child ever passed in one act. Evidence is produced to show that this peculiarity may either be inherited as a physiological variant of the normal, or may be acquired as the result of certain diseases or injuries.

Some account is given of enuresis resulting from abnormalities of bladder function, and also of psychogenic enuresis.

Case histories are given to illustrate the various forms of functional enuresis.

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