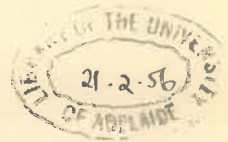


ESSENTIAL ENURESIS.



A THESIS SUBMITTED FOR THE DEGREE OF
DOCTOR OF MEDICINE IN THE
UNIVERSITY OF ADELAIDE. ^{1.}

by

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PROLOGUE.

Enuresis is an affliction which occurs in all races and in all sections of communities. There have been, and still are, many and widely varying opinions on the aetiology of the condition. Consequently there has been equally as great a variety of measures practised in therapeutic regimes, none of which are satisfactory.

This work therefore is an original contribution to the subject and claims to have advanced medical knowledge and practice in the following ways:-

(1) It chronicles the author's personal interest in, and observation of, the natural history of enuresis as part of the experience of ten years of rural general practice. Such a study is necessary in order to assess the value of the multitudinous factors listed in the literature on enuresis. The phenomena of the natural history suggested a concept of the condition and a plan for further research and treatment.

(2) A new concept of the condition termed

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- (2) (Contd.) "Essential Enuresis" is described. This is based on an original description and discussion of the attainment of urinary continence. The view presented is that essential enuresis is primarily a physiological state or entity in contrast to the widely held opinions that it is a symptom or a disease.
- (3) On this basis the apparently paradoxical clinical findings can be coordinated, and the essential types of enuresis are defined and explained.
- (4) A statistical analysis of the data obtained during the research discredits familial and hereditary factors in the aetiology of enuresis in an approximation to a random sample of the enuretic population.
- (5) The natural history and concept of essential enuresis enabled a therapeutic regime to be planned and initiated. This required the design and development of an

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- (5) (Contd.) instrument which made the treatment both practicable and domiciliary.
- (6) The successful results of this treatment suggest that it is specific and lend cogent support to the validity of the thesis.

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PART I.

ENURESIS: A PROBLEM IN ALL RACES.

PREAMBLE.

"Much has been written, but relatively little is known of this condition which distresses mothers, shames children, and frequently baffles physicians."

1.
W. C. Davison.

This statement has applied almost as well in the years since it was penned as it did when it concisely described the position regarding enuresis a quarter of a century ago.

Enuresis is one of the most harassing of medical problems which may affect a family. During childhood, it is exceeded in frequency of incidence by few conditions other than trauma and the acute infectious diseases. The considerable anxiety and labour, which are caused by enuresis, may be prolonged for years, so that these factors combine to make it an important part of paediatric practice.

The magnitude of the problem is epitomised in the authoritative "Memorandum prepared by the Joint Committee of the British Medical

Association and Magistrates' Association on Psychiatry and the Law" (B.M.J.1948). From this statement on the subject of enuresis, one can estimate that approximately half a million children in the United Kingdom are affected with this condition at any time. During the 1939-1945 World War, the rationing and limited supply of fuel, household linen and clothing made any extra demands upon these commodities a very real burden. Enuresis does make such encroachments on a large scale so that these material considerations made the administrative authorities fully aware of the condition although they could offer but little alleviation during the national emergency. However, for this and other reasons attention has been focussed on the graver medical effects which this ubiquitous condition produces on both the unfortunate sufferer and his family. Although enuresis showed up clearly as a major problem in England during war time, it is almost certainly as prevalent in peacetime, and as widespread through Western civilisation, if not throughout the world. Unfortunately the

conclusions of the Committee do not offer any fresh encouragement for those suffering from enuresis.

Historical.

The prime object of modern medical treatment is to apply measures which are directed specifically to the aetiological (and ecological) factors of any given condition. Some attempt was made to follow this scientific method in mediaeval practice, before resorting to purely empirical means, even though the link between aetiology, real or supposed, and therapy was mostly very tenuous. Hence the histories of views on aetiology and treatment are closely interwoven in enuresis as well as in most other diseases. Axiomatically, the recognition of a condition must precede any attempt to establish its aetiology or treatment.

There is little doubt that enuresis has always existed in the human race. Mettler states that the problem of enuresis is as old as child management. (Mettler, 1947, p.703). Observations on the young of mammals lead one to believe that they, too, are faced with the problem of developing continence, and indeed these observations,

while lending force to the belief that enuresis always has been a feature of childhood, are described later in relation to the present author's concept of the basic nature of essential enuresis and the natural means of attaining urinary continence.

The early recordings of medicine have references which, in their context, appear to describe under the title of incontinence of urine, the condition which is now termed enuresis (Adams, 1849; Adams, 1844-1847; "The Natural History of Pliny" 1855).

It is often stated that after Galen, virtually nothing new was written about medicine for a thousand years. Still (Still, 1931) considers that Fontanus (1642) almost certainly wrote from Sebastian's work (1540) who in turn copied from Cornelius Roelans (1450-1525) who most probably was recording medical practices which dated back to Roman and Grecian Medicine, so that their writings on "incontinence of urine" record the recognition of the condition at their own periods and almost certainly at previous ages. These writers refer to a bladder weakness, which was presumed

to be the cause of the condition, and recommended the use of powdered animals' bladder. Daniel Sennert in his "De Mullierum et Infantium Morbis", recommends "pigs or sheeps bladder roasted with Hares' testicles and cock's weazen", a truly elaborate hormone and organo-therapy so that the wheel has turned full circle in the recent treatment with gonadotropin (Blau, 1926, Cioffari and Clark, 1947).

James Primerose in his "Partes Duae De Morbis Puelorum" of 1659 recorded various measures including pigs' bladder but wisely cautioned the reader not to put too much reliance upon them (Still, 1931) a recommendation which unfortunately could be given with the scores of different treatments which have been tried since.

As far as can be ascertained, native races throughout the world are afflicted with enuresis. Personal enquiries have revealed that enuresis occurs in India, the Orient and among the Australian aborigines.

The native tribes vary a great deal in their reaction to the condition. Some, especially

the more primitive ones, apparently accept it without attempting to do anything in the matter (Albrecht, 1948). Other tribes practise punitive measures which include physical discomfort and ridicule. These procedures are of differing intensity, but at times are sufficient to cause the death of weaker children (Rattray, 1929). The custom among some New Guinea and other tribes is for the babies to be carried continuously and to be suckled when they cry. When an infant urinates or defaecates, the person holding it will jerk quickly to one side to prevent soiling of his person. This usually interrupts the course of excretion (Mead, 1935). By so doing these people are probably wiser than they know, for these procedures have important elements in common with the present author's views on the factors which normally assist in the conversion from the infantile automatic bladder to urinary continence. This "Conditioning" will be discussed at length in Part II. The general opinion of authors (Mowrer, 1938, Bakwin, 1949, Campbell, 1937, Davison, 1924) is that native races have no greater, and probably less incidence of enuresis than have the white races.

In his masterly review of the literature, Anderson (Anderson, 1930) reveals that few if any other medical conditions can have had so many different factors invoked in aetiology, or have had so many agents used in therapy.

Treatment has ranged through surgical, neurophysical, psychological, endocrinological, physical, penal, paediological and pharmacological measures, in which last category therapeutic agents beginning with acetate and ending in valerian have been used (Earl, 1934). In the latter half of last century belladonna and atropine gained a great reputation which has persisted until the present day. Simon Baruch in 1889 reported on the use of belladonna in 30 cases with phenomenal results, most cures being effected within three days (Watson, 1945), and similar specificity has been claimed periodically since then.

The use of gonadotropins has been mentioned above. When other hormones such as thyroxin were identified they were soon used empirically in enuresis (Williams, 1918).

The list of anatomical or pathological lesions, which have been considered as

aetiological since the early belief that some bladder weakness was a cause of enuresis, makes a formidable array. It includes most of the diseases which affect the genito-urinary-system and adjacent systems together with many neurological, remote local, endocrine, and constitutional defects. (Abt's Pediatrics, 1924; Bakwin, 1949; Campbell, 1937; Anderson, 1930). After the development of radiology, the belief that spina bifida occulta was the main cause of enuresis was widely accepted (Ezrikson, 1926; Mertz, 1933). Unfortunately, because of the time of fusion of vertebral epiphyses, X-Rays of the spines of children will usually give an appearance of spina bifida occulta. This condition is now dismissed as being of any major importance aetiologicaly. The genuine cases of spina bifida occulta are only too likely to have true incontinence. Mertz for instance reported only 1 cure in 6 cases treated by laminectomy.

When the autonomic nervous system was better understood, but thought of in terms of two antagonistic mechanisms, the sympathetic and vagal, this was also considered to offer an explanation - "Enuresis is a condition of local

vagotonia" (Muldawer, 1927).

With the advent of the theories of psychology in the nineteenth century, an explanation of enuresis in terms of psychomotor action (Freud, 1916; Janet, 1890 and 1927) was sought and has been steadily expanded since then, notably by the German psychologists and paediatricians.

Enuresis has such a high incidence that it is frequently noted in the history of parents and siblings. Consequently it must have been considered as partly familial and hereditary from the earliest observations. As psychological patterns are regarded as being influenced by heredity and even more by familial factors, it is natural that hereditary and familial theories of the aetiology of enuresis are not only closely linked with psychological theories, but are part of them. This view is summed up as follows by Roboz (Roboz, 1947) : -

"The genealogic tree is of much help in establishing the prognosis." "I believe that in these cases the influence of hereditary factors manifests itself with unparalleled intensity. Enuresis may not infrequently occur as an

equivalent of epilepsy." "It can be assumed that psychologic causes are always responsible for the manifestations of the periodic forms, inherited inclination probably being low in such children. They can be treated adequately by any kind of psychotherapy, especially suggestion."

However, Hubert (Hubert, 1933) who also stresses hereditary factors states that the results of treatment have no relation to the family history (and that no drug appeared to be of particular value).

From an historical point of view then, the position may be summarised as follows:-

- (1) There is reason to believe that enuresis has always been a problem in child management. It is referred to in the early writings and is present in all native races to the best of this author's personal knowledge and reading.
- (2) A great number of factors have been and still are invoked in the aetiology of enuresis, but none have proved satisfactory as a general basis for therapy.
- (3) Treatment has been based on factors

(3) (Contd.) believed to be aetiological and has also been purely empirical. There is no unanimity of opinion upon therapy, and no indication that a specific therapy has been established.

Definition of Essential Enuresis.

The causation is the crux of any discussion on bed-wetting (Earl, 1934). Hence a definition must be in accordance with one's concept of the aetiology of Essential Enuresis. As an introduction, I prefer to extend Zappert's definition (Zappert, 1920), which is accepted by Campbell (Campbell, 1937), in the following way: Essential enuresis is the involuntary and unconscious voiding of urine after an arbitrary age limit of three years in the absence of significant congenital or acquired defect or disease of the nervous and urogenital systems and without significant psychological defects.

The underlined portion of this definition is my own addition and the context of Part II will elaborate this view which automatically excludes factitious enuresis. (vide infra).

Descriptive Classification of Enuresis.

Enuresis is usually classified in accordance

Descriptive Classification of Enuresis (Contd.).

with observed facts as follows:-

- (1) Nocturnal, i. e., occurring at night.
This is the commonest form.
- (2) Diurnal, i. e., occurring by day only.
This is relatively uncommon without concomitant nocturnal enuresis.
- (3) Continuous from infancy.
- (4) Reappearing after a period of continence.
- (5) Regular, with few if any dry nights unless some precautions are taken.
- (6) Sporadic, with varying intervals of continence.
- (7) Factitious, i. e., a volitional act due to fear of the dark, dislike of the cold, or other reasons, so that the act is not really one of incontinence or enuresis.

The incidence of Enuresis in the populace.

The figures for the incidence of enuresis will depend on the age limit beyond which it is first considered to be present, and the completeness of the data. With regard to the age limit, this is of course determined by the definition of

The incidence of Enuresis in the populace (Contd.).
enuresis.

It is rare to obtain complete data on the incidence of enuresis for the following reasons:-

- (1) It is difficult in actual practice to obtain a true random sample of the populace largely because of the next two factors.
- (2) Memory of both the occurrence of the condition and its time of onset and offset is very fallible in many people.
- (3) Many people deny that they have had or are still afflicted with the condition, because they feel some stigma attaches to it. For this reason the familial and parental incidences recorded (Kanner, 1937) are probably inaccurate, and are at variance with my own findings.

Incidences of 16.1% at 5 years of age and 8.5% at 10 years of age were found, during a military call up, in 1000 consecutive males who made statements from their own knowledge and memory (Thorne, 1944). From this and other sources (B.M.J., 1948, Bakwin, 1949, Browne and Forde Smith, 1941, Blau, 1926, Sheldon, 1934) as

The incidence of Enuresis in the populace (Contd.)

well as my own series an approximate Age/incidence curve (Fig. 1) has been constructed of children who have wet beds. Despite the Bellevue Hospital series which suggests a relatively static part of the curve in childhood (Bakwin, loc.cit.), it seems that the incidence at 10 years is about half that at four to five years of age. The important thing to notice is that there is a continuously falling curve from infancy.

I think that all will agree that the majority of patients with enuresis have wet the bed continuously from birth. Probably less than a third of all cases have relapsed after some period of continence during early childhood.

There are widely divergent reports as to the incidence of enuresis in the two sexes, although most authors regard males as being affected more frequently than females. However, the great male preponderances which are claimed cannot be true of the bulk of cases. The true state of affairs is probably that in the younger age group males and females appear to be more nearly equally affected, but later, males predominate because, in them, enuresis is more persistent than in females.

The historical survey indicates that the incidences have been associated with a very large number of physical, psychological and hereditary factors, but there is little unanimity of opinion, and statistical data are confusing (Anderson, 1930, Michaels and Goodman, 1938).

Noticeably greater incidences occur in mentally defectives and epileptic children, but generally speaking it is notable that the affliction appears to occur at random.

Finally, the importance of enuresis in medical practice, and the extensive literature on the subject, are at strange variance with the paucity of information in many standard text books of medicine, two of which during my late student days and early graduate practice, had no specific article on this perplexing subject (Conybeare, 1932, Price, 1933).

PART II.

THE NATURE OF THE AUTHOR'S CONCEPTS OF ESSENTIAL
ENURESIS AND THE SCOPE OF THE RESEARCH.

INTRODUCTION TO A DESCRIPTION OF THE
NATURAL HISTORY OF ENURESIS.

The author's attention was attracted to the natural history of enuresis because of his experience in general practice in rural areas (Crosby, 1948,1949). The main reason which prompted this study was the failure to obtain satisfactory responses by applying in various combinations, the different methods of treatment advocated in the literature. During this period some patients were sent to other general practitioners and specialists with equally unsatisfactory results. Medical practitioners have been so discouraged over the results of therapy in the past that there is now a widespread tendency to counsel parents "to wait and let the child grow of it" when first consulted on the matter, or after an attempt at treatment with fluid restriction, alkalis and belladonna.

Most authors regard enuresis as a symptom rather than as a specific entity, (Bakwin, 1949; McGregor,1948; Campbell, 1937; Whinsbury-White,1948). The bewildering array of opinions as to the aetiology may be divided into four principal schools of thought which consider enuresis to be due to:-

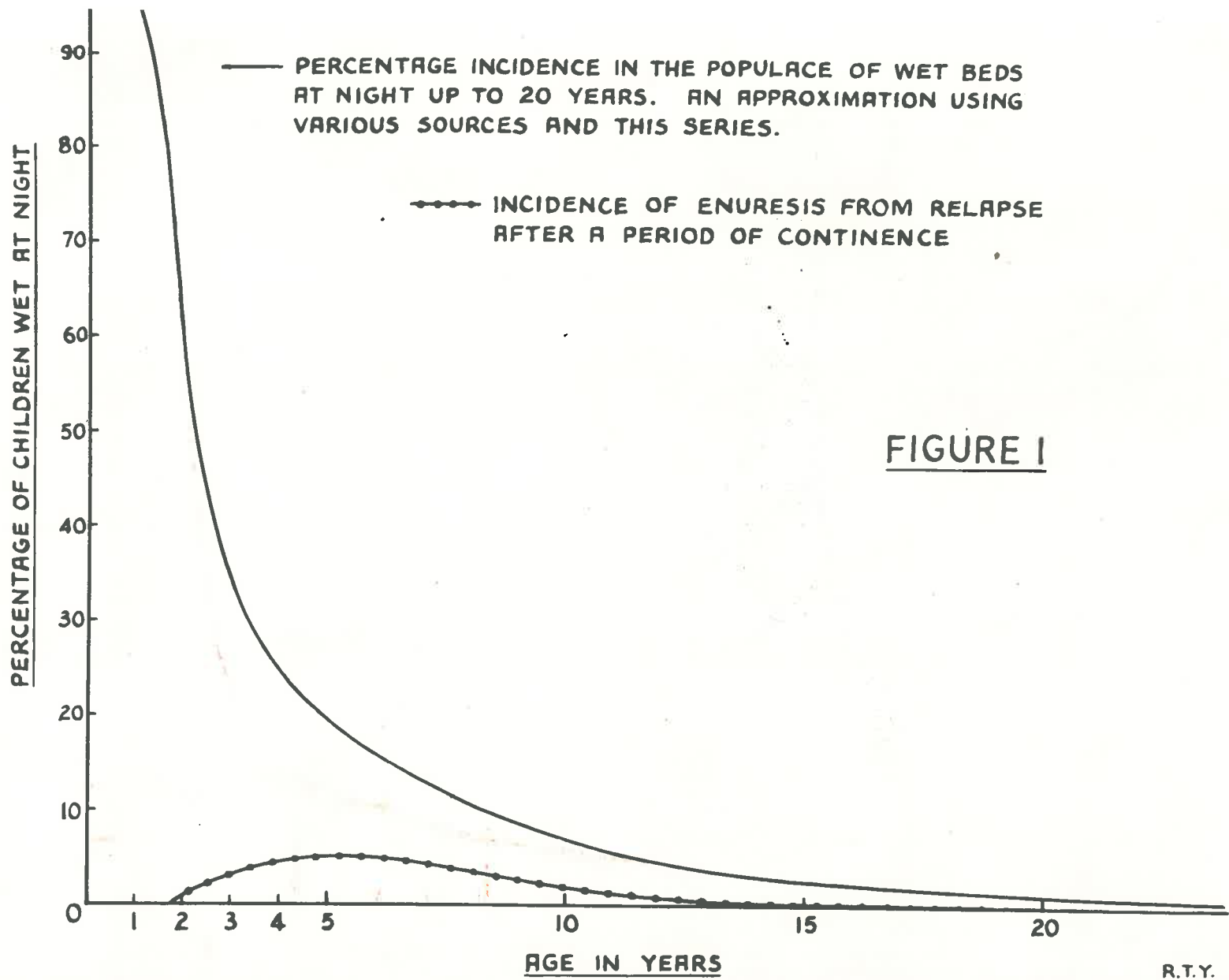


FIGURE I

- (1) Psychomotor activity.
- (2) Heredity.
- (3) Local urogenital defects or pathology.
- (4) Constitutional diseases.

To anticipate later discussion, I believe that the work described in this paper supports the view that in the great majority of enuretic patients, the removal of psychomotor activity is not necessary for cure. The results of this investigation examined statistically, discredit hereditary and familial tendencies.

Many therapeutic agents have been used in treatment. R. C. Browne and Fords-Smith (1941) have examined the effects of the drugs most commonly used for enuresis, in controlled experiments which did not show any one of these therapeutic agents to have specific value when compared with an inert control substance. The Age/Incidence Graph (Fig. 1) shows how unreliable it is to claim a cure when therapy necessitates long periods of treatment in view of the continuously falling curve. In Thorne's series (Thorne, 1944) only 10 out of 161 male persons, who remembered having enuresis at 5 years of age, regarded themselves as having been cured by any therapy; the others considered that they "just grew out of it". More than 50% of the children, who have

enuresis at 4 years of age, will be continent at 10 years of age. For this reason, any non-specific treatment can be instituted with occasional apparent success especially if the treatment is prolonged over many months or even years, but repetitive results will not be obtained.

As treatments have been involved, either empirically or from factors considered as aetiologic-
al, their failure in practice suggested the desir-
ability of a fresh approach to the problem. Continued
observations on patients, and reflection on the
results therefrom, led to the concept that essential
enuresis is not primarily a symptom but an entity or
state arising from physiological activity, and not
of anatomical, pathological or psychological origin.
On this basis, a method of treatment was evolved and
its success in application is cogent support for the
concept.

A Summary of clinical Observations made on Enuresis
during Ten Years of General Medical Practice.

It is necessary to discuss behaviour and
psychological patterns in relation to diagnosis
generally. There can be a wide variation in both of
these patterns without necessarily indicating
abnormality. The mental processes and behaviour of
the ordinary person operate about a particular mean

which represents his type. There may be, however, a considerable variation from this type over a short period, depending on precipitating factors. The psychological state as well as the physiological state is a dynamic one and the findings at examination must be related to the internal and external environment, before anger or depression or glycosuria or tachycardia can be labelled pathological -- in fact, they may be the signs of normal responses. In these matters the general practitioner, situated where rather small centres of population exist, steadily increases his knowledge of the people with whom he deals and about whom he learns a great deal from outside sources as well as medical consultations. As a result, he should be competent to judge whether a child or adult is different from his fellows or from his previous state, in some respect, to the point of psychological abnormality, even though the specific abnormality is not diagnosed. Likewise, the school-teacher who deals with the same children over a period of years is usually able to detect similar differences in his charges. I have discussed these matters with several teachers in rural areas and they bear out some of my general observations with regard to certain aspects of juvenile enuresis.

Brief Summary of Clinical Observations.

The following statements summarise my observations and apply to the great majority of patients whom I have encountered with nocturnal enuresis. The child may be an only one or may occupy any position as is shown in the evidence of this series (See Table p55). The reaction of the sufferer to his parents, his siblings, his playmates and his world, does not reveal any abnormality until the unhappy consequences of his enuresis are brought home to him, and he becomes afflicted with a sense of shame about the condition. This sense of shame is usually a prominent feature, and is shared to some extent by the parents and other members of the family, so much so that the incidence and ill effects of enuresis are often concealed. These patients dislike discussing the subject with parents or with the doctor. They avoid the subject just as any child or adult will avoid discussing a topic distasteful to him. In most of the families observed in rural general practice, the behaviour of the individual families was not such that one would expect it to produce enuresis in a child, nor

were the sufferers, at the onset of enuresis, exceptional in such a way that it seemed likely that they would react in this way to normal patterns of family behaviour. Added to this, the position of the child in the list of siblings, and the occurrence of enuresis in other siblings, appeared to be determined at random. In any group of children, it is not possible, as a rule, from anamnesis and examination to detect those afflicted with enuresis, unless the specific admission is elicited. Sometimes the patient's urinous odour or a urine rash may be suggestive, but generally speaking there are no diagnostic criteria, despite the physical and psychological factors often invoked by authors in discussion on aetiology. The patient must display the specific feature, viz. bed-wetting, which is in fact the diagnosis.

Some or many of the local and general physical conditions regarded as direct or accessory aetiological factors by many authors can be present and the children remain continent. Conversely, often none of these factors can be demonstrated in children suffering from enuresis. In continent children, the onset of conditions regarded as aetiological, for enuresis, e.g., oxyuriasis, tonsillitis and more especially inflammatory states of the uro-genital

system, rarely result in enuresis. Even when there is urinary pain and frequency, such patients usually wake in order to micturate. Certainly enuresis should not be cured by the means described in this paper if physical or pathological defects were aetiological. Enquiry into the past history of people who do not reveal any physical or psychological characteristics diagnostic of enuresis will show that approximately one-fifth have suffered from enuresis in younger life.

My own experience supports the view that except in epileptic and mentally retarded families, the better class families are at least as likely to be affected as the "poorer" class. The present series included four doctors, three lawyers and a considerable number of similar status among the parents of affected children.

Another apparent anomaly which causes much thought is that often a first child is an enuretic from infancy while subsequent siblings are continent from an early age. These siblings often receive much less training, attention or affection than the first, especially if the pregnancies were unwelcome.

If enuretic children were of unstable emotions or of physical defect, they would not

be expected to take up a normal life when enuresis ceased, especially if it were considered that they had been expressing their disapproval of their internal or external environment by enuresis. Despite the shame and indignity to which these children are frequently subjected, most of them remain lovable and loving children.

In nearly all cases of enuresis, restriction of fluid intake, even from early in the afternoon, will not have any noticeable effect on the course of enuresis, although there is a reduction in the total amount of urine passed. Usually this reduction is not appreciated unless an actual assessment of the urine volumes is made. I suggest that this anomalous failure of what should result in a reduction in the physiological requirements to pass urine, has been one of the main reasons for invoking psychomotor activity as the cause of enuresis, for at first sight it seems the only reasonable explanation.

Summarising, therefore, it appears that the two most important points are:-

- (1) the lack of significant features for diagnosis, and
- (2) the fact that the majority of cases are enuretic from birth and appear as

(2) (Contd.) the residuum of subjects on an uninterrupted and falling age/incidence curve (Fig.1).

The Effects of Enuresis on the Sufferer and Family.

(1) The effects upon the sufferer: The young child at first may be unaware of the fact that enuresis is a problem, if the parents and family have made no point of it, even though he experiences some discomfort from being soiled. It is, however, almost impossible for the parents to regard the condition with equanimity as the years pass. The child also becomes aware of his oddness by comparison with his fellows. He soon learns to keep silent on the subject. The attempt to train or encourage the child, or to apply therapy, in any case brings to the child awareness that the condition is undesirable, even when he is not subjected to censure or punishment. The mere fact that the child cannot sleep or romp in the beds of his parents and siblings, makes him miserably conscious of his defect and leads to the assumption of shame, even though he knows that he is not responsible. It is

remarkable how this shame encompasses the whole family. This is to some extent a natural development, but it is largely fostered by the teaching that enuresis is a psychological defect and that the condition is inherited (Bakwin, loc.cit.).

As the child grows older, so does his fear increase that his defect will be known. He does anything to hide his wet clothes and the exhibition to the neighbours of washing. In this he is usually abetted by the family. Many parents express impatience or fury that the child seems to become remote and indifferent when censured for the habit, not understanding that the child can do little else when he is assured that he is culpable and yet knows that he is the victim of, and has no control over, this particular affliction. In turn, restrictions on holidays, recreation, boarding school, occupation and marriage are liable to accentuate the misfortune of being an enuretic, and to emphasise the fact that the sufferer is set apart from his fellows. Punishment ranges from mild censure and daily scenes over the wet bed, to active measures of thrashing and even more degrading acts, such as semi-public washing of the attire, or rubbing the face in the soiled

attire. The spoken threat of treating the child with indifference or dislike, and the accusation to the child, that he does not love his parents, because of his enuresis, are common practices and must inflict psychological trauma on the recipients. The child can meet all this only with tears, a stoical mask of indifference, or rebellion, the last being repressed often till adolescence. The amazing thing is that on recovery, most children show so little signs of their travail.

The following are brief accounts of representative histories which illustrate the effects of enuresis on the sufferer.

Case 46, a male aged six years and the first of two children, had enuresis as much as six times a night and was subjected to severe physical punishment in the parent's despair, although she was usually an affectionate mother. At first examination, he bore many bruises, but although averse to discussing his affliction, he did not exhibit resentment of his mother, and accepted his fate with stoical fortitude, having long since ceased protesting that he could not help his enuresis. One wondered what the outcome would be, but since being cured he has remained a cheer-

ful and affectionate child.

One male parent, who had practised physical and mental punishment on his teenage boy (Case 7), expressed infuriation at the child's seeming indifference. He was amazed when, at a long interview in the child's presence he was convinced that enuresis was a pivotal consideration in the boy's life, and that the child primarily referred almost any proposal affecting his life to the likelihood of his state being revealed to others.

Case 19 (aet. 28) had deliberately avoided matrimony, and felt limited in the vocation which she could choose, because of her enuresis.

Case 35, a business woman aet. 22, admitted that for her, marriage in the future depended on continence of urine being established. She had had years of previous treatment, including years of supervision by a psychologist.

Case 54 (aet. 24) was already separated. Her husband had known of the condition before marriage, but however much discussed beforehand, enuresis must present a formidable problem in

marriage. This patient, when travelling, stayed awake all night to avoid exposure through soiled hotel linen. It was useless to advise her that she should not worry for she had already payed too high a price for her enuresis. She was chronically short of sleep, usually retiring at 1 a.m. and waking at 6 a.m. in an effort to lessen the effects of enuresis. Her eagerness for cure was pathetic.

Several of the older sufferers have volunteered the statement that being told that neither they nor their parents are to blame, is itself a great relief from anxiety. A well-educated 24 year-old single woman (Case 73) had had, among other treatments, psychological advice for her persistent enuresis. She had avoided matrimony and had retreated from her family and friends. She considered that the attitude of her parents and family to herself, and her own feelings toward her family, did not warrant enuresis if such behaviour was the result of psychological reactions to her immediate environment. Consequently, she felt that she was abnormal in at least one aspect of her personality. She states that, irrespective of the outcome of

treatment, she has gained a sense of psychological normality, in place of her past anxiety, which was just as great in relation to possible psychological abnormality as the physical fact of enuresis.

With regard to parental action, I stress that most parents are driven by exasperation, worry, and failure of treatment, to acts of which they are ashamed and which are not a gauge of their true characters.

Psychological factors progressively complicate enuresis. These secondary anxieties have a vicious effect in reducing the likelihood of recovery.

(2) The effects upon the family: Some of these have already been illustrated. Although wet beds are not usually a problem during infantile life, there is great competition to get a child dry, both from a utilitarian and a pride aspect. It is amusing to note the number of parents who claim to have a continent child and yet have regular washing of sheets and diapers. This parental pride undoubtedly leads to great efforts in training and leads to an earlier imparting of shame to the child. The

labour entailed alone, as the child grows older, becomes a burden. Anxiety as to the child's future mounts and becomes a haunting worry, especially to the mother. Family arrangements are involved, and there is usually the constant trouble to avoid a revelation of the condition to others, in explanations of restrictions on holidays and allied activities.

Enuresis in a child may have a profound influence upon the mother, more especially when she is taught that enuresis is hereditary, or that parental behaviour is responsible by causing a psycho-pathology of which enuresis is the expression.

The following example illustrates many of the usual difficulties caused by enuresis. The mother of a male child, the second sibling, had a third pregnancy at the time when the child's enuresis was beginning to cause upset to the child and family. Three years later the third child also gave every sign of being a severe enuretic, while the elder one resisted all treatment. The mother, fully occupied with normal family burdens, to which were added the extra labour of two enuretic children and the mounting anxiety about their future, coupled with the

family scenes over enuresis, developed depression and a fear of further pregnancy. I knew that she was genuinely progeneritophile until after the second pregnancy. Fear of pregnancy led to very real marital troubles in a marriage which had every promise of being most successful. A fourth pregnancy resulted in a house of tension and a petulant dispirited wife faced with all the old problems to which was added a baby. Meanwhile, the elder boy reached the end of primary education and, being in a rural area, boarding school or private board became essential if he was to have the opportunity of fulfilling academic promise, but board is difficult to obtain for children suffering from enuresis.

In any family afflicted with enuresis these factors vary in number and intensity, and are direct complications of enuresis. I do not believe that they are causal, although, as stated before, I consider that these factors make enuresis more persistent and more difficult to cure.

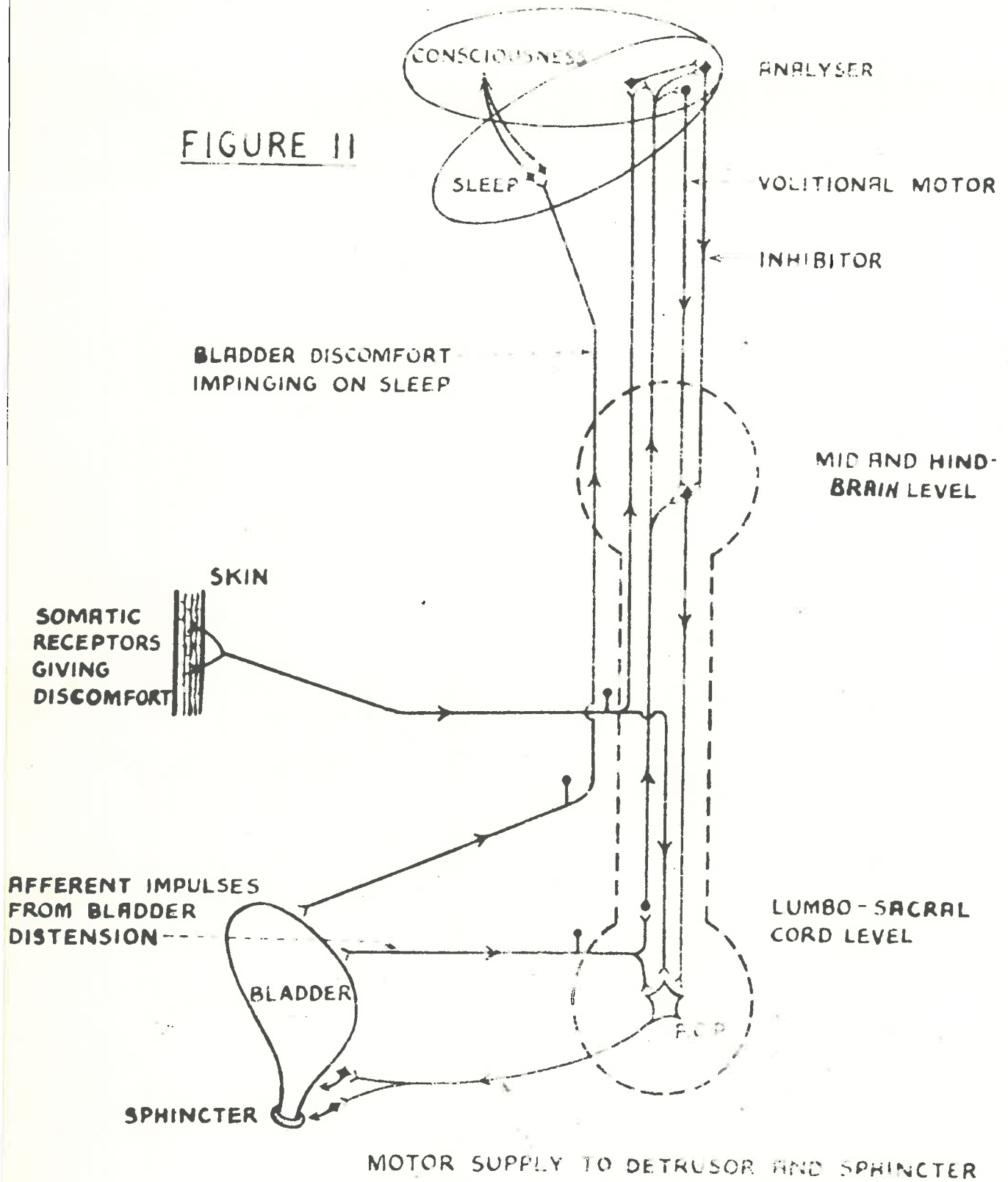
Urinary Continence.

Micturition, like other essential functions such as vasomotion, shows evidence of spinal control which has been superseded largely, and certainly directed by higher centres during progressive encephalisation. The anatomy and physiology of micturition have been described accurately and at length by prominent authorities (Barrington, 1914; Brodal, 1948; Denny-Brown and Robertson, 1933; Goltz and Freusberg, 1874; Kuhn, 1949; Learmonth, 1931; Langworthy and Kolb, 1933; Newman, 1949. Muellner and Fleischner (1949) have described fluoroscopic examination of volitional micturition and inhibition and have concluded that the pubococcygeus muscle (voluntary striate) is responsible for higher control, and that when this muscle is inactivated by pathology or neural disease, automatic micturition only is possible. However, in view of the bladder control some women retain after severe prolapse, and the prolonged inhibition which can enable the bladder to double its capacity after the first desire to urinate, it is difficult to believe that the detrusor is not under higher inhibition.

The normal stimulus for micturition is intravesical tension. A cystometrogram normally gives a rising type of curve on which serrations appear,

SCHEMATIC REPRESENTATION OF BLADDER CONTROL

FIGURE II



depending on both bladder volumes and rate of filling. At about 16 centimetres of water pressure a high spike heralds urination. In adults the first desire to micturate is experienced at about half the volume which will cause imperative urination (Best and Taylor, 1945). This physiological capacity is in turn about half the anatomical capacity of the bladder. The physiological values vary with the rate of bladder filling, the emotional state, cold and other factors. For instance, observation on a few children and adults show that in cold weather the volume of urine tolerated may show a reduction to half that which in hot weather produced the same acute desire to micturate.

Fig. 11. is a schematic representation of the bladder control. The "centre" for the bladder is shown as a dumb-bell shape to take in the sacral cord and brain stem components. Afferent impulses arise from stimulation by a filling bladder and may result in three responses.

(1) A cord reflex seen after spinal shock.

This is not effective in completely emptying the bladder in the adult.

(2) A more co-ordinated reflex exhibited in decerebrate animals so that the bladder is emptied.

- (3) A variable response in higher intact animals which are awake. Urination may ensue or the animal may sustain inhibition for a longer period of time.

Usually the exercise of volition can initiate urination at almost any time, irrespective of the degree of bladder filling.

Hemiplegia in adults often results in temporary or permanent inco-ordination of micturition, whereas hemiplegia from birth injury does not seem to interfere so much with the automatic bladder of infants. Thus, as in other functions, it appears that the higher centres progressively preponderate over lower ones in the phylogenetic and ontogenetic scale, and that the longer the higher control is exerted, the less likelihood there is of the lower centres re-establishing effective control. Likewise, the longer that a conditioned response is maintained, the harder it is to extinguish it (Pavlov, 1927).

The present author believes that the study of micturition alone will not permit an understanding of urinary continence. For nocturnal continence two separate features are essential.

Firstly, there must be inhibition of detrusor activity and micturition so that urination does not occur too early as a response to increasing bladder volume. This inhibition, together with the increasing anatomical capacity of the bladder as the child grows older, may allow the child to be continent all night without micturating, if the volume of urine in the bladder does not reach the threshold value which is necessary to initiate micturition. More than this is necessary for continence, so that, secondly, this inhibition must remain prepotent over visceral afferent stimuli tending to initiate micturition until the discomfort of a filling bladder will disperse sleep, thus allowing the person to micturate voluntarily.

After all, in both continent and enuretic children, a time will come when the bladder contents reach the physiological limit. When this happens the continent child wakes to micturate, but the enuretic child does not. The experimental findings in this research suggest that enuretic children rarely have a physiologically full bladder at night.

The threshold volume necessary to wake the patient or to initiate micturition varies in both

normal and enuretic children and adults. This is shown by the variation in the volume of urine which is passed by continent individuals when woken by the desire to void. This variation illustrates the reserve of inhibition which is available in cases of deep sleep due to fatigue, and represents one essential difference between the normal and the enuretic person. With long established continence, the discomfort of a full bladder can amount to severe pain on waking from deep sleep.

The importance of these two factors, bladder inhibition and rousing from sleep, will be elaborated in relation to the present findings in enuresis.

Essential Enuresis: a Physiological State.

The Age/Incidence curve of Fig.1 shows that all infants are incontinent from birth for a variable period of time. After approximately 18 months of age there is an interval when the labour associated with a "wet" child is regarded as some degree of nuisance, but the child is not regarded as abnormal until about three years of age or more.

At five years of age some 20% to 25% of children are still enuretic and a complete reversal

of opinion has occurred as to what constitutes a normal child with regard to urinary habits. Four-fifths of the children who as infants were "wet" and were of course considered normal, are continent at five, but the residual enuretic children are considered abnormal. If one narrows the gap too closely there comes a stage when the criterion for a normal child's urinary habits on one occasion becomes the diagnosis for enuresis on the next.

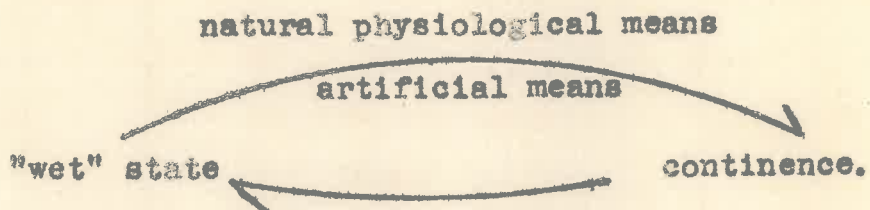
This leads to a consideration of the methods by which infants are converted to urinary continence, and requires more precise definitions of the state termed enuresis.

From the observations described in this paper, the author gradually developed these concepts:-

- (1) that in most children essential enuresis is basically a physiological state, and does not involve as a primary cause, anatomical defect, pathology or psychological aberration;
- (2) that conversion from enuresis to continence usually occurs by physiological responses; and finally -
- (3) a further reversal from continence to

(3) (Contd.) enuresis is always possible.

This can be represented as follows:-



Whether conversion can occur by natural means, or is acquired by artificial means alone, is a fundamental question. By "natural" I mean a physiological process which is inherent in the reaction of the organism to the environment. By "artificial" I mean those methods such as "potting", training, suggestion, hypnosis or volitional attempts to extend control during sleep, making continence dependent upon culture.

I believe that there is a natural physiological mechanism for conversion to urinary continence and that it is the usual pathway adopted. The method of treatment described by the author aims to assist the physiological conversion process.

The Conversion Process for the Establishment of Continence.

If this approach be right, there should be evidence of the means by which the natural conversion process operates.

Sherrington (Selected Writings, p.203) describes several reflexes operative in the spinal animal in relation to micturition and defaecation. Some of these reflexes tend to avoid soiling. Pinching the tail of a monkey after spinal transection in the midthoracic region sometimes interrupts micturition. "Micturition is imminent when (spinal) defaecation sets in, is postponed" (Sherrington, 1939). Strong sensory stimuli will inhibit micturition in dogs which have had a dorsal transection of the cord (Goltz and Freusberg, 1874). These show that there are responses, inhibitory to micturition, organised at a spinal cord level, although I believe that, in the human being, continence largely involves "analyser" function. In any case "analyser" activity is necessary for the establishment of conditioned responses or for reinforcement of them.

Observations on different mammalia show that they are not prone to enuresis. This is not to be confused with so-called house training. From a teleological point of view, natural continence is an expected development, as a fouled animal is liable to leave a stronger spoor for his enemies and he runs a greater risk of bacterial infection. The continent animal has a material advantage for

survival. In this connection it is of interest that patients, treated only for enuresis in this series, have recovered spontaneously from mental ulcers and mild vulvovaginitis after enuresis ceases, despite prior treatment for these conditions in the belief that they were causal factors.

If continence was artificially acquired and totally lacking in phylogenetical development, the faculty should show early dissolution under stress (Hughlings Jackson, 1884 et seq). In alcoholism, in narcosis for therapeutic reasons, and in recovery from anaesthesia it is very surprising how infrequently incontinence occurs. After extirpation of the anterior half of a dog's cerebral hemispheres the animal slept almost continuously, not even taking food, nor were sexual reflexes elicited, and yet the dog would wake just prior to defaecation and micturition. The dogs survived about a year (see Pavlov, Fig.18, p.363). Bell and Karnosh (1949) describe the after effects of a right cerebral hemispherectomy in a man when bladder and bowel and sphincter control were unaffected.

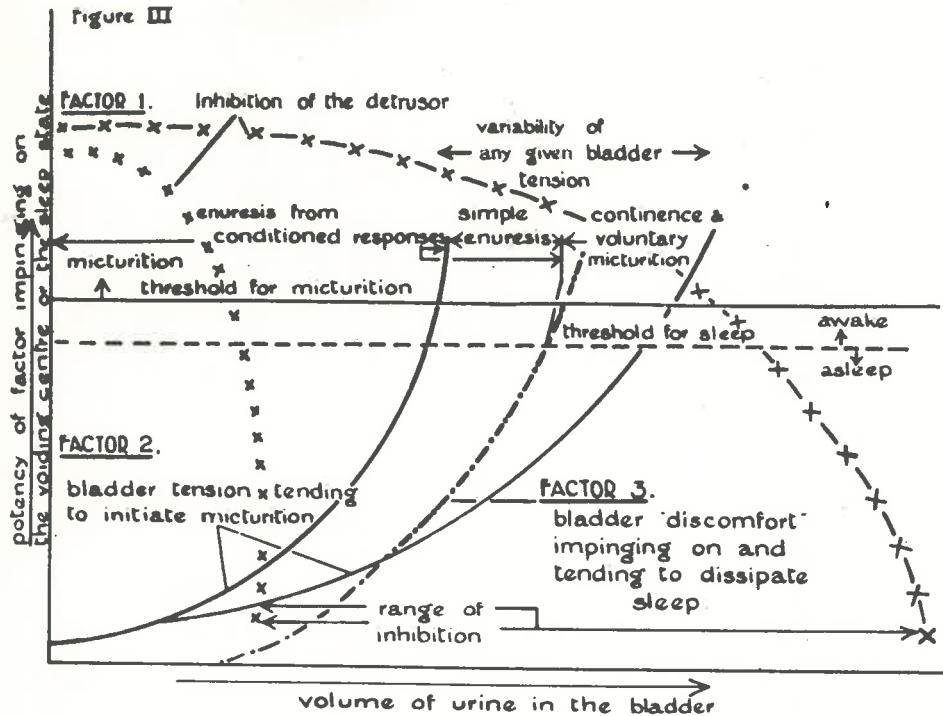
Continence, dependent on volitional control, would not be expected in these conditions, especially in alcoholism where there is often an inevitable diuresis, associated with gross incoordination. Actually,

urinary control is a very rugged mechanism when once continence is established.

In the human there is a clue to the conversion process in the discomfort evinced by an infant in the soiled state. I completely disagree with the statement "It is plausibly said that an infant who cries when his nappies are wet, is crying in apprehension of the disturbance of having them changed" (MacGregor, loc.cit.).

I consider that the wet urinous state which I term "somatic discomfort", acts as an inhibitory stimulus, which at the onset of micturition, causes an unconditioned response tending to inhibit continuation of micturition, by inhibiting the detrusor and contracting the sphincter. This must not be interpreted in any way as a suggestion that micturition of itself leads to an inhibition of urination. It is the "somatic discomfort", consequent upon being soiled, which produces inhibition. Reinforcement of this inhibition from repeated soiling would be expected to produce a gradual increase in the tone of inhibition of the bladder so that the volume of urine necessary to initiate micturition would increase also. As the bladder fills the inhibitory tone diminished in

A Schematic Representation of Three Factors whose Inter-reactions determine Urinary Continence during Sleep.



Factor 1. and Factor 2. are inversely related and the resultant will have some effect on Factor 3. for any given bladder volume.

Local pathology of the genito-urinary system may lead to a direct increase in the potency of Factor 2. for any given bladder volume; a reduction of inhibition (Factor 1.) would further enhance this potency.

A conditioned response to micturate may over-ride all these factors and initiate urination during sleep.

prepotency over the increasing stimuli which travel over the afferent arm of the bladder reflex arc. At the same time, increasing bladder distension causes an increasing visceral afferent bombardment of the brain which tends to impinge on and disperse sleep. In the sleeping child then, the filling bladder is producing stimuli which are active at two separate "centres", the bladder reflex centre and the "sleep centre", and the resultant effect is determined by three co-existing factors, depth of sleep, inhibitory tone and stimulation of bladder afferents. If the inhibitory tone is sufficiently prepotent, the discomfort of a filled bladder will disperse sleep before the bladder afferents initiate micturition as a reflex act (See Fig. 3). This process may begin very early because young infants often remain dry until waking, immediately urinate and then cry from the discomfort of being wet.

The natural conversion process may be reinforced by some training methods but more often there is a danger that these artificial methods will interfere with the natural process and even make the condition worse. There is evidence in support of this contention. Many children, of

parents who have not tried to train the child, attain continence before acquiring speech. This is especially noticeable in some homes where the first child has had enuresis after much training, and as a result, the parents have refrained from all efforts in view of the past dismal failure, and yet the siblings are continent from an early age.

The Mechanisms in Different Types of Essential Enuresis.

("Response" and "Reflex" are used interchangeably in this paper, "Reflex" generally being used when referring to older papers).

I believe that the different types of essential enuresis are explicable in terms of concepts which are summarised below for reference. Some have already been elaborated.

- (1) The immediate "somatic discomfort" from being soiled by urine is a natural potent stimulus for the inhibition of further micturition. By repetition this leads to an increase in "tonic" detrusor inhibition.
- (2) For complete continence the inhibition of the detrusor must be sufficiently prepotent over the stimuli tending to cause micturition during sleep so that the discomfort of a

- (2) (Contd.) filling bladder will disperse sleep effectively before micturition occurs.
- (3) Conditioned response to micturate can be acquired. These may interfere with or extinguish the "somatic discomfort" inhibition of detrusor activity.
- (4) Adaptation to many types of discomfort, including that of being soiled, can be rapidly attained, during sleep as well as when awake.
- (5) The inhibition developed by "somatic discomfort" is liable to ^dminution and extinction as a result of 4, as well as by 3.

I. The Simple Type of Essential Enuresis is that where the diurnal and nocturnal volumes of urine passed are relatively normal. The filled bladder initiates micturition before the discomfort of the distending bladder reaches the threshold to disturb sleep. These cases are seen when there have not been assiduous efforts at training which often results in totally undesired compulsive ^{urination.} The simple type of enuresis is the only one to do well with

fluid restriction by which the bladder volume does not reach reflex threshold during sleep. A period of fluid restriction or hot weather which causes sweating at night, may allow the establishment or restoration of a pre-potent inhibitory tone which is aided by a lessened depth of sleep consequent upon the removal of the repeated discomfort of being soiled. True continence may ensue, as a result of this simple form of therapy.

The simple type is not common. The occasional equivalent of this type is seen in the wet bed which occurs as a result of excessive tiredness in a normal child before the inhibitory reflex has been sufficiently long or deeply established. On such occasions the child usually wakes immediately after from the discomfort of being wet.

Many of the older children who have had the complicated type of enuresis when younger, show evidence of reverting naturally to the simple type before becoming continent. The compulsive conditioned responses to void gradually diminish in potency and suffer extinction, leaving the patient with the simple form of enuresis, i. e., where a full bladder will not wake him. The past history will show an alteration from regular nocturnal enuresis where small volumes of

urine are voided, to irregular enuresis with large volumes of urine either flooding the bed during sleep, or being passed on waking in the morning. These children often give a history that with fluid restriction, a quiet house, and not going to bed too early, they will be dry without having to urinate during the night.

II. The Complicated Type of Essential Enuresis.

The simple type of enuresis is often complicated by superimposed conditioned responses which initiate micturition. Some of these are immediate responses, and some are well established delayed responses.

(1) Immediate Responses which may initiate Micturition.

A common history is that it is almost impossible to go to the child during sleep without finding him urination in sleep or just having completed the act. In these cases light, noise or physical disturbances from early training have been the conditioning stimuli which initiate micturition so that urination is not related to physiological necessity or to a time interval after going to bed. Even doors slamming in the wind are enough to cause some children to urinate. Sometimes the history will reveal that there may be a dry bed when there has been a particularly quiet night

in the whole house.

(11) Delayed Responses which may initiate Micturition after an Interval of Sleep.

Many infants are made comfortable at bed-time and then regularly disturbed after a certain time interval to be "potted". This is an ideal basis for the establishment of a delayed conditioned response which may even be repetitive. It is especially dangerous if the child is not properly woken or if the procedure is repeated during the night. Some parents, in the hope of establishing continence, put the child to bed after a compulsory toilet, "pot" him again at the parents' bed-time, and then wake up at midnight to repeat the process. Careful taking of a urinary pattern in the manner to be described in the next section, will show that some children urinate repetitively right through the night.

The following are the details of 4 consecutive nights, 3 from the "urinary pattern" and the fourth the beginning of treatment of Case 41 (See treatment record.). This child had been assiduously "trained" from infancy, the infant being bedded down near 7 p.m. and then "potted" at about 9 p.m. and again at the last moment

when the parents retired. Such a system is a common practice with many parents. The results are highly suggestive of a delayed response.

CASE 41.

Bedtime	1st night	2nd night	3rd night	4th night
	8.30 p.m.	8.30 p.m.	8.30 p.m.	8.30 p.m.
Times and volumes at urination	11.25 p.m. 2 ozs.	11.2 p.m. 1½ ozs.	11.17 p.m. 1½ ozs.	11.30 p.m. 2 ozs.
during sleep	2.05 a.m. 1½ ozs.	2.33 a.m. 1½ ozs.	‡ 2.04 a.m.	1.35 a.m. 1 oz.
Waking time and volume passed on waking	7.4 a.m. 1½ ozs.	7.30 a.m. 2 ozs.	7.30 a.m. 1¾ ozs.	7.15 a.m. 2½ ozs.

‡ wet bed - the tube came adrift during micturition.

The history and "urinary pattern" of many patients suggest that the simple type is complicated by both immediate and delayed responses to micturate in sleep.

Methods of Investigation and Assessment in this Series.

Most of these patients were referred to me by medical practitioners and all had had previous treatment over varying periods of time. Histories and examinations were recorded on printed schedules, covering two foolscap pages. These could be amplified where necessary, and were as follows:-

CASE HISTORY.

SURNAME	CHRISTIAN NAMES	A. SEX

ADDRESS _____ PHONE NO. _____

DATE OF BIRTH _____ B. AGE _____

C.

FAMILY	PARENTS		SIBLINGS				
	F.	M	1	2	3	4	5
Age							
Sex							
Enuretic							

D. HISTORY OF ENURESIS:

FIRST CONTINENT	RELAPSED	ALWAYS ENURETIC

Incidents related to onset _____

	FREQUENCY	CONTROL
Diurnal		
Nocturnal		

X Does Patient void in sleep _____

" " sleep deeply _____

" " wake easily _____

Training in infancy:

Much	Some	None	Punishment

E. PAST TREATMENT:

F. PAST ILLNESS:

Diphtheria _____ Scarlet Fever _____ Measles _____ Mumps _____

Pertussis _____ Sore Throats _____ Tonsils _____

Out	Infected

Worms _____ Other illnesses _____

G. DEFECTS OF NERVOUS UROGENITAL SYSTEMS:

H. NERVOUSNESS:

I. ENVIRONMENT AND FAMILY:

PARENTS OCCUPATION

Nervous _____ Major upsets _____

Attitude to the child _____

"Social grade"

High	Low	Medium

J. SCHOOL:

Liking	Progress	Difficulties

K. RESTRICTIONS:

Holidays _____
Boarding School _____
Scouts, etc. _____
Occupation _____
Marriage _____

L. REMARKS ON THE PATIENT'S ATTITUDE TO THE CONDITION:

Equanimity	Worry

EXAMINATION

M. Mentality:

Bright	Normal	Poor	Subnormal

N. C. N. S.

O. Urogenital System

P. Other Notes:

CHARTING OF THE URINARY PATTERN AND ESTIMATIONS.

NAME

DAY AND NIGHT FREQUENCY, VOLUME AND TIME OF MICTURITION AS
DETERMINED BY INSTRUMENT AND OBSERVATION.

DATE	BEDTIME	TIME OF MICTURITION	VOLUME OF URINE
------	---------	---------------------	-----------------

Urinary Estimations.

Chemical test:

12-hour specimens - 8.30 to 8.30 - for 3 days.

DATE	TIME		VOLUME	SPECIFIC GRAVITY	pH	UREA	CHLORIDES	TEMP. AT ANALYSIS
	DAY	NIGHT						

Special attention was given to the question of diurnal continence and day time urinary habits as far as these were known. An assessment of the child's mental age was made from both information and observation. It is necessary to gauge the intelligence of the patient.

The main points looked for in examination were obvious spina bifida indication, spasticity, trophic effects or awkward gait, and especially perineal anaesthesia. The urine was tested, particularly for albumen and sugar.

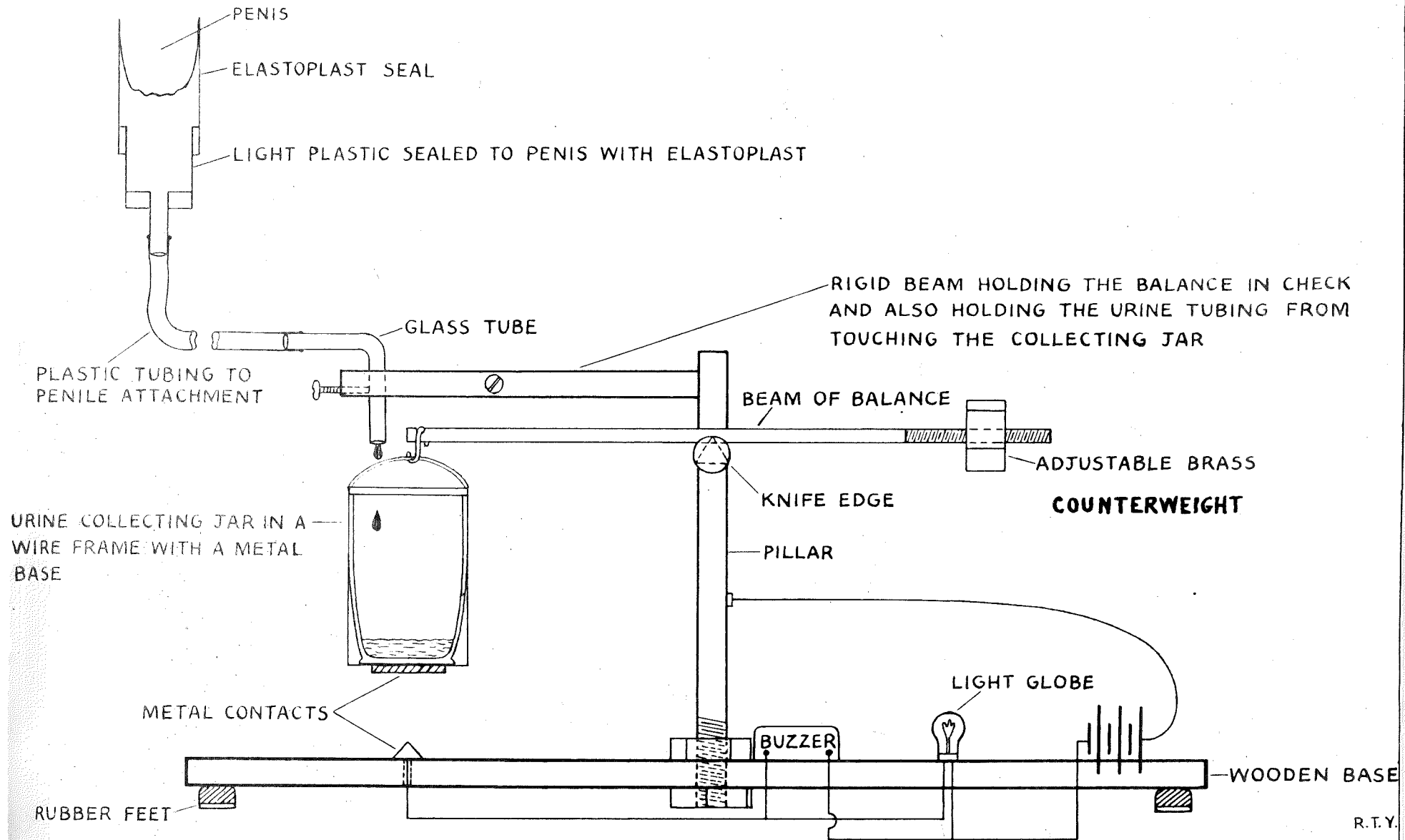
The child with normal diurnal control, and without signs of neurological disorder or gross urogenital disease, was considered suitable for treatment on these grounds alone. The more regularly such a child wet the bed, the better, provided, of course, that there was no reason to suspect factitious enuresis.

For at least three days and nights, all the urine was collected from each patient. The times of ~~urination~~ and the volumes of urine were recorded. This continued a "urinary pattern" which was charted (see sample).

In females, this necessitated waking the patient at intervals, but with males a device was evolved which gave a close approximation to the

Sample Chart

DIAGRAM OF
APPARATUS FOR NIGHT "URINARY PATTERN" IN MALES



natural pattern which occurred at night. The device was a simple knife-edge balance (see diagram). The counterweight allowed the sensitivity to be set so that any desired volume would cause the receiving jar to descend, thus making an electrical contact which caused a light or a buzzer or both to signal to the observer that micturition had occurred. The time of micturition and volume of urine were recorded and the jar replaced without waking the child if possible. Usually the setting of the counterweight made the balance act after 10 to 15 ml. of urine had collected. The observer then waited until micturition ceased. Taken in conjunction with the history, this "urinary pattern" enables the type of enuresis to be ascertained.

In therapeutic practice there is no need to delay treatment after the history and examination, in order to obtain this "urinary pattern", unless there is reason to suspect that there may be some neurogenic disorder of micturition which may be suggested by the history or by undue diurnal frequency, or by precipitancy. When treatment is instituted, frequently from the first night, and almost always after the first few nights, micturition is arrested after only a few millilitres or less of urine have been passed involuntarily. The amount of urine passed after waking is recorded and this automatically gives the night record of "urinary

pattern". This can be augmented by the day record if desired. The majority of enuretics, however, can be treated without recourse to diurnal pattern. Should the night volumes not show signs of reaching normal proportions, then the diurnal pattern should be estimated.

In this series of cases, the urine was collected for three days and kept in 12-hour portions, 8.30 to 8.30. The constituent volumes of each 12-hour period and the times at which they were passed were known. Each 12-hour sample was then tested for pH, specific gravity, chloride and urea concentration. This was done in this series to find how many children had noctilluria and among other things what relation this bore to probability of cure (Friedell, 1927) and aetiology (Smellie, 1949), (Cameron, 1927).

Results of Urine Estimations.

The estimations for chlorides and urea were done in duplicate using Schale's method and the hypo-bromite method respectively.

The urine estimations have been done at all months of the year. Only two patients have shown a night specific gravity of less than 1010, but these results were not repeated on other nights.

Examples of consecutive night readings with one low specific gravity are:-

SPECIFIC GRAVITY ON CONSECUTIVE NIGHTS				
CASE NO.	1st NIGHT	2nd NIGHT	3rd NIGHT	4th NIGHT
22	1022	1018	1008	1018
23	1010	1023	1023	-
35	1010	1026	1021	-
55	1007	1027	1026	-

One girl (Case 48) gave night readings of 1014, 1011, 1010 with day readings of 1021, 1026, 1020; the total amounts of urine passed by day and by night being approximately equal. This child has done very well and in the three months since treatment has not had a single wet bed.

One could not detect any relation to urinary acidity or alkalinity, the same child frequently showing variations on consecutive nights, or on "wet" nights, these variations seeming to depend on food and fluid intake and physical activity.

In enuretic and normal children, it is usually possible to identify the night urine from the day urine by the reversal of concentration of urea and chlorides. The day urea concentration is usually lower than the night and the day chloride concentration is higher, frequently both

reversals being present, although the chloride reversal is the more constant. Generally, there is an increased concentration of both chlorides and urea in the older children in both day and night samples.

To summarise the effective results of these various estimations on urine, the "urinary pattern" was the only information found to be of positive value in relation to enuresis. No other results appeared to be significant as an indication of the aetiology or prognosis of enuresis.

AN ANALYSIS OF THE FAMILIAL HISTORY OF SEVENTY-THREE (73)
PATIENTS PRESENTING THEMSELVES BECAUSE OF ENURESIS.

The following family histories and incidences
 were found in this series:

TABLE OF FAMILY HISTORIES.

Patient		Parents		Sibs						
Case No.	Sex	M	F	I	II	III	IV	V	VI	VII
4	F	+	-	P						
15	M	-	-	P						
16	F	-	-	P						
26	M	+	+	P						
29	M	+	-	P						
35	F	-	-	P						
41	M	-	-	P						
43	F	-	-	P						

TABLE OF FAMILY HISTORIES (Contd.)

Patient		Parents		Sibs						
Case No.	Sex	M	F	I	II	III	IV	V	VI	VII
70	M	-	-	P						
72	M	-	-	P						
2	M	-	-	F -	P					
5	F	-	-	P	M -					
9	M	-	-	P	M +					
11	M	-	-	P	F -					
12	M	+	+	P	m +					
27	F	-	-	F -	P					
31	F	-	-	P	F -					
34	M	-	+	P	f +					
36	F	-	-	M -	P					

TABLE OF FAMILY HISTORIES (Contd.)

Patient		Parents		Sibs						
Case No.	Sex	M	F	I	II	III	IV	V	VI	VII
37	M	-	-	M -	P					
38	M	-	-	F -	P					
46	M	-	-	P	f +					
50	M	-	-	P	m +					
51	M	-	-	P	f +					
54	F	-	-	F -	P					
56	F	-	-	P	f +					
57	F	-	-	P	F -					
58	F	-	-	P	M -					
65	M	-	-	P	M -					
67	M	-	-	P	F +					
68	F	-	+	P	F -					
71	F	-	-	F +	P					

TABLE OF FAMILY HISTORIES (Contd.)

Patient		Parents		Sibs						
Case No.	Sex	M	F	I	II	III	IV	V	VI	VII
75	M	+	-	P	F+					
78	M	-	-	M-	P					
1	F	-	-	M-	F-	P				
6	M	-	-	P	F+	F-				
8	M	-	+	P	F-	m+				
10	F	-	-	P	F-	M-				
13	M	-	-	M-	F-	P				
17	F	-	-	F-	F-	P				
23	M	-	+	M+	P	M P				*
24	F	-	+	P	M+	M+				
39	M	-	-	F-	P	m+				
40	F	-	-	F+	P	F-				

TABLE OF FAMILY HISTORIES (Contd.)

Patient		Parents		Sibs						
Case No.	Sex	M	F	I	II	III	IV	V	VI	VII
42	M	-	-	F -	F +	P				
44	F	-	-	M +	P	f +				
45	M	-	+	P	F +	F -				
47	M	+	?	M -	P	M P				▼
48	F	-	-	M -	P	m +				
49	M	+	-	P	M +	M +				
52	M	-	-	F -	F	F -				
53	M	-	+	P	F +	M -				
62	F	-	-	F +	F -	P				
73	F	+	+	P	M -	F -				
74	M	-	+	F -	P	M -				
77	M	+	-	P	F -	m +				

TABLE OF FAMILY HISTORIES (Contd.)

Patient		Parents		Sibs						
Case No.	Sex	M	F	I	II	III	IV	V	VI	VII
7	M	+	-	M +	P	M -	F -			
18	F	-	-	M -	M -	M -	P			
19	F	-	-	P	F -	M +	F -			
20	F	-	-	F -	M -	F -	P			
59	M	-	-	M +	P	F -	M -			
60	M	+	-	F -	P	M -	M -			
61	M	-	-	F -	M -	P	F -			
66	M	-	-	F -	F -	F -	P			
69	F	+	+	M -	F -	P	M +			
76	M	+	-	F +	M -	P	F -			
25	M	-	+	M +	F -	F -	P	F -		

TABLE OF FAMILY HISTORIES (Contd.)

Patient		Parents		Sibs						
Case No.	Sex	M	F	I	II	III	IV	V	VI	VII
30	M	-	-	F -	M -	M -	M -	P		
55	M	-	-	P	M -	F -	m +	f +		
63	M	-	-	F -	P	M -	M -	F -		
64	M	-	?	M -	M -	F -	F -	F -		
▼ 14	M	-	-	F -	M -	F	P	M P	F	▼
21	M	-	-	F -	M -	F -	F -	F -	M -	P

P = patient.

M = Male sibling

F = Female sibling

Small letter m, f = enuretic wet sibling aged less than 3½.

▼ = 2 patients in one family.

+ = History of enuresis.

- = No History of enuresis.

ANALYSIS OF 73 FAMILY HISTORIES.

Incidence of enuresis in parents of enuretics.

73 couples	No. of couples	No. of enuretics.
Both male and female enuretic at 5 years	4	8
Male parent only, enuretic at 5 years	9	9
Female parent only, enuretic at 5 years	9	9
Neither parent enuretic	51 ^x	-
Total	73 = 146 persons	26

x = 1 Mother was dead and there was no relevant history

x = The History of one Mother was equivocal.

Incidence of Enuresis $26/146 = 17.8\%$.

Incidence in siblings.

	Patients	Males	Females	Total
		49	27	76
Siblings continent by 3½ years of age		36	53	89
Siblings enuretic at any age		19	18	37
Wet siblings aged less than 3½ years of age		7	8	15
Siblings with a history of enuresis at or after 3½ years of age		12	10	22

Incidence rate in siblings 22/111 = 19.8%

Male Siblings V. Female Siblings

	Male	Female	
Wet	12	10	22
Dry	36	53	89
	48	63	111

$\chi^2 = 0.91$
 $P > .30$

Discussion on Incidence.

The incidence of enuresis in parents in this series is 17.8% at 5 years of age. This incidence rate is no higher than that assumed for the population (see incidence curve).

There is no significant difference in the sex incidence in parents.

The incidence rate in the siblings is 19.8% in this series. This is no higher than that assumed for the population.

These two facts taken together discredit any theory of inheritance factors and familial tendencies.

The incidence rate in male siblings is not significantly greater than the incidence rate in female siblings.

Much evidence suggests that in the older age group, males predominate over females in incidence. This occurs because males persist for a longer time with enuresis. Two factors can explain this. Firstly, the female soils her perineal area more immediately and more extensively than the males, and this area in experimental animals has the most inhibitory effect on micturition. Secondly, the male may direct the stream of urine away from the body so that he is soiled less and more slowly. The reasons why these two factors are significant have been dealt with earlier.

The Apparatus used for Treatment.

The method of treatment used in this series aims at extinguishing any conditioned responses which initiate urination, and to reinforce the natural method of building up the "inhibitory tone", which is considered necessary for continence.

To practise this method it was necessary to devise a means of detecting the earliest onset of involuntary micturition so that at this onset a variable stimulus could be applied. If the "somatic discomfort" previously described did in effect tend to produce an inhibition of detrusor activity, an additional slightly noxious stimulus should be able to reinforce this process, and restore its potency provided that the region of application was effective for this purpose. I hoped to avoid the perineal and genital area as the region for applying the mild stimulus, for obvious reasons, and fortunately the loin and lateral abdominal regions have been completely satisfactory sites. It was expected that repeated urination initiated as conditioned responses would be inhibited and gradually extinguished, and that at the same time the inhibition of micturition would begin to be developed in the direction of allowing the bladder tension to increase

until sufficient to arouse the patient to full consciousness. After much consideration, electrical means seemed the only practicable way for this to be done. Many technical difficulties were met and had to be overcome. The final unit proved satisfactory for clinical use in hospital or at home (see photograph Appendix 1).

The essentials of the unit are:-

- (1) Urine electrodes for detecting the onset of micturition.
- (2) A sensitive relay.
- (3) Stimulating electrodes for applying an adjustable stimulus.
- (4) A generator of signals to the observer.
- (5) A source of electro-motive force.

There are separate male and female urinary electrodes, but the remainder of the apparatus is interchangeable. The electrodes must be kept electrically clean or preferably made of non-corrosive material.

The urinary electrodes consist of metal strips separated by a gap which is bridged by urine, surface tension sufficing to maintain contact. One drop of urine is sufficient to carry a current large

enough to operate a sensitive relay. These urine electrodes must be adapted accurately to the patient and need to be easily changeable after micturition.

On ~~urination~~ the relay operates circuits which produce two effects:-

- (1) Signals are made for the observer (parent or nurse) by both light and sound so that the patient will be attended to.
- (2) A stimulus, capable of variation to any desired intensity, is applied to the patient. The stimulating electrodes are carried by an elastic belt fastened around the waist, and are applied to the loin region. The stimulus has to be varied for different patients, and often during treatment. The doctor or parents can test the stimulus on the skin of his forearm. An intensity just less than enough to cause discomfort at this site is satisfactory for the first night. Subsequently, the intensity is varied as seems necessary depending on the reaction to the stimulus and the depth of sleep. The instrument is connected to the elastic

(2) Contd.

belt by a four-wire cable which is covered, so that it is resistant to acute bending, as a safety measure, to avoid entangling the sleeping patient.

Actual Treatment.

All these patients were treated by this method alone in order to assess the results accurately, although I shall point out later why adjuvant treatment is theoretically desirable in some selected cases.

Eight (8) children and three (3) young adults were treated in hospital or the treatment was begun in hospital. The remainder were treated at home by the parents and this is desirable for several reasons. At home the child is in the environment to which he must be adapted, and the switch from hospital to home represents a hurdle which fortunately does not seem so far to have had deleterious effects by causing a relapse. The parents are more likely to carry out instructions to the letter as they are vitally concerned. Unless an actual clinic is set up at an hospital, there is the recurring necessity to instruct changing staff in the

method. In a mixed ward, there are always other duties which may take the nurse from the scene at the important times. Should the nurse have to leave the ward, it is essential that the instrument be switched off to avoid unnecessary discomfort to the child, especially if the child is young.*

The most important general instruction is that the observer must be within sight or hearing of the patient and instrument, and it is for this reason that the unit has been so constructed that there can be no stimulus without visual and auditory signals. When treatment is domiciliary it is essential that one parent must be sensitive enough to wake easily with the noise, otherwise it would be necessary for an attendant to remain awake. With older patients who do not mind a more intense stimulus, it may not be necessary to have an attendant after the first night or two. Most children over 8 years of age elect to do all the arrangements themselves, and are happy to sleep alone after the first few nights; usually the parents are instructed to leave the communicating doors open so as to be able to hear the auditory signal. If the patient is alone, then it is essential that the stimulus be sufficient

* Some instruments had variable thermo-relays which limited the duration of the stimulus to 5 - 15 seconds.

to ensure waking, otherwise small points of electrolysis can appear at the stimulating electrodes and, of less importance, the batteries would run flat. A daily report to the doctor is desirable for the first few days in order to review results and give advice. The results of each night including the volumes of urine passed, and the effect of the stimulus are recorded. The following is a typical record from Case 41:

TREATMENT RECORD.

A COMPLETE RECORD OF CASE 41.

DATE	BED TIME	HOUR WOKEN BY INSTRUMENT	HOUR WOKEN NATURALLY	AMOUNT PASSED	DEGREE OF URINARY ARREST: REACTION TO STIMULUS	REMARKS EASE OF WAKING, ETC.
14/6/49	7.30	11.30 1.35	7.15	2 oz. 1 oz. 2½ oz.	Immediate arrest " "	Cried slightly on waking. Wake immediately
15/6/49	7.00	9.45 10.40 1.20 4.20	7.20	3 oz. 1 oz. 2¼ oz. 2 oz. 1¾ oz.	Immediate arrest " " " "	as above except cried longer. Cut back stimulus from 110 to 90
16/6/49	7.00	1.00 6.10 7.15		3¾ oz. 2½ oz. 1 oz.	Immediate arrest " "	Upset very little on waking
17/6/49	7.30	12.30 7.00		2¼ oz. 3½ oz.	Immediate arrest	as above
18/6/49	7.00	9.55	8.20	1½ oz. 7 oz.	Immediate arrest	as above

TREATMENT RECORD (Contd.)

DATE	BED TIME	HOUR WOKEN BY INSTRUMENT	HOUR WOKEN NATURALLY	AMOUNT PASSED	REMARKS DEGREE OF URINARY ARREST; REACTION TO STIMULUS EASE OF WAKING, ETC.
19/6/49	7.05	2.20 7.15		3½ oz. 3½ oz.	Immediate arrest) Child found holding contacts away from his back with hand, when awoken.
20/6/49	7.15	2.15	7.15	5¾ oz. 6 oz.	Immediate arrest) not upset when waking. Wide awake when voiding.
21/6/49	7.15		7.15	6 oz.	Did not wake during night.
22/6/49	7.15	11.00	7.25	1 oz. 5 oz.	
23/6/49	7.15		7.00	6 oz.	Did not wake during night.
24/6/49	7.20		7.10	7 oz.	" " " " "
25/6/49	7.00		7.00	6 oz.	" " " " "
26/6/49	6.45		7.15	6 oz.	" " " " "
27/6/49	6.45		7.15	7½ oz.	" " " " "
28/6/49	6.45	6.00		8 oz.	Did not go to sleep again after being woken.
29/6/49	7.05		2 a.m. 7.05	9 oz. 10 oz.	Given approx. 1½ pints of water before going to bed) Woke of own accord 2 a.m. (9 oz.)
30/6/49	6.50		7.15	4¾ oz.	Approx. 1 pint water before going to bed.
1/7/49	6.50		7.15	10¼ oz.	Approx. 1½ pints water before going to bed.
2/7/49	6.50		7.20	8½ oz.	Machine is not attached.

It has been proved conclusively that this treatment can be successfully undertaken at home by parents of ordinary intelligence, provided that they pay due attention to the printed instructions and subsequent supervision.

From the beginning, the child is allowed to eat and drink as he pleases, and to lead his usual life, and to practise his usual hour of retiring. As the child has been assessed from his history and examination, there has already been a diagnosis as to the probable type of enuresis, and from this it will be known whether it is desirable to increase fluids at an early stage. Usually, one first sees an inhibition of the varied conditioned responses which are believed to initiate micturition. Treatment has to be prolonged until these responses are thought to be extinguished. Time alone will prove whether they have been permanently extinguished or whether circumstances will provide stimuli for the restoration of them. Later, increasing inhibition of the detrusor occurs, so that the child has greater intervals between urination and retains more urine in the bladder before being woken by the electrical stimulus. At this stage the child may be dry all night and be continent on waking in the morning if he has not taken much fluid, or if he has sweated considerably in the

night due to hot weather.

At this stage the child's enuresis has been converted to the simple type of enuresis which will allow continence with treatment by fluid restriction. However, it still remains to be proven whether this inhibition of detrusor activity will be prepotent over the increasing potency of intra-vesical pressure which results from greater filling of the bladder. Such proof is obtained by increasing the fluid intake of the patient so that his bladder cannot hold a night's urine. He then experiences some more electrical stimuli as a rule. Some patients, however, exhibit complete inhibition after increasing the fluid intake at this stage so that they do not experience further stimuli. As an arbitrary rule, treatment is discontinued after the patient has woken naturally to urinate during five consecutive nights without any enuresis, this usually indicating cure.

PART III.

RESULTS OF TREATMENT AND DISCUSSION.

The establishment of continence is the only satisfactory criterion of successful treatment for enuresis, whereas "improvement" is an unsatisfactory state. Most of the methods hitherto practised for the treatment of enuresis recommend fluid restriction and perhaps lifting of the child at night, together with some special therapy. Consequently, the child may be reduced from nightly enuresis to two or more "wet" nights a week. By comparison with the past, such can be called improvement but it is more apparent than real, and has only reduced the labour of dealing with soiled linen without really ameliorating the other complications of enuresis. When the particular regime is abandoned through the lack of further progress, this "improvement" is rarely maintained.

An occasional lapse from continence is experienced by nearly all normal children in the more tender years. The history of Case 40 illustrates such incidents. The mother, at the first interview, stated that her other two children "never wet the bed" and was quite sure on the point. The child with

enuresis was referred on by a consultant paediatrician and treatment was begun at the Adelaide Children's Hospital, and completed at her home, complete continence ensuing in $3\frac{1}{2}$ weeks. This girl had not a single lapse in the next six months, but the mother confessed that her other two children, each on a separate occasion, had wet the bed. She recollected then that there had been other rare examples in the past, which had been forgotten as they did not cause anxiety. One can confidently state that no child, continent between the ages of three and eight years of age, has really been free from a lapse of continence on at least one night. Consequently, no treatment could guarantee to prevent the occasional wet bed. Apart from this consideration, the present author's concept of essential enuresis as a physiological state is such that he expected that some patients would relapse as a result of conditions which might occur after treatment, but that such relapses should be readily amenable to a repetition of the treatment. These expectations were realised and are discussed in the appropriate parts of the text.

Frequent reference is made in this paper to the increase in the bladder volumes as a result of treatment. As all intra-urethral manipulations were avoided in this series, there is no absolute check on

this. If the increase were only apparent due to a large residual urine being expelled, one could have expected to find evidence of the distended bladder during preliminary examinations, more especially in those where 10 ounces or more would have to be postulated to explain the increase. However, all the evidence pointed to a real increase of bladder capacity.

The complete series of patients, who have been treated by this method, has been divided into three classes as follows:-

Class I - Aged $3\frac{1}{2}$ - $10\frac{1}{2}$ years, without obvious neurogenic or urogenital cause for enuresis. Twenty eight (28) patients were cured out of twenty nine (29).

Class II - Aged $3\frac{1}{2}$ - $10\frac{1}{2}$ years, suspected of having neurogenic or other cause for enuresis or incontinence. Four (4) patients were cured and one (1) greatly improved out of six (6). One (1) was a failure.

Class III- Aged over $10\frac{1}{2}$ years, without classification from history and examination. Eighteen (18) patients were cured

Class III (Contd.) - and there was only
one outright
failure in twenty
three (23) patients.

HISTORY OF ENURESIS PRIOR TO TREATMENT AND RESULT OF TREATMENT.

TABLE III A. : 29 CASES.

CLASS I. AGED 3½ - 10½ YEARS.

HISTORIES SUGGESTING ESSENTIAL ENURESIS.

CASE NO.	AGE		SEX	ENURESIS			TREATMENT STARTED	RESULT	REMARKS
	YRS.	MTHS.		FROM BIRTH	RE-LAPSED	ALSO DIURNAL			
10	9	2	F	+			Oct., 47	Cured	See text
46	6	-	M	+			Nov., 47	Cured	See text
4	3	8	F		aet. 3		June, 48	Cured	See text
27	9	3	F	+			June, 48	Cured	
32	8	6	M	+			July, 48	Cured	Not treated since. Relapsed at mothers illness
47	3	10	M	+			August, 48	Cured	A rare wet bed
16	5	1	F	+			August, 48	Cured	See text
39	5	-	M	+			Nov., 48	Cured	Still continent a year later
20	6	11	F	+			Feb., 49	Cured	1 wt bed in 9 months
44	8	6	F	+			Feb., 49	Cured	
12	4	1	M	+		at times	March, 49	Cured	
18	8	11	F	+			March, 49	Cured	2 wet beds in 9 mths.
36	9	-	F	+			March, 49	Cured	
15	10	4	M	+			March, 49	Cured	See text
13	9	8	M	+	several times		April, 49	Cured	See text
14a	6	5	M	Dry at 2	aet. 3 after surgery		April, 49	Cured	See text

TABLE III A.: (Contd.)

CLASS I. AGED 3½ - 10½ YEARS.

HISTORIES SUGGESTING ESSENTIAL ENURESIS.

CASE NO.	AGE		SEX	ENURESIS			TREATMENT STARTED	RESULT	REMARKS
	YRS.	MTHS.		FROM BIRTH	RE-LAPSED	ALSO DIURNAL			
14	10	3	M	Dry at 2	aet. 5 after measles		May, 49	Cured	See text
5	6	3	F	+			June, 49	Cured	Complete continence since.
41	5	1	M	+			June, 49	Cured	Complete continence since.
40	7	7	F	+			June, 49	Cured	Complete continence since.
37	4	4	M	+			June, 49	Cured	
3	7	6	F				June, 49	Cured	
6	7	6	M	+			July, 49	Cured	See text
23(a)	3	9	M	+			July, 49	"	
22	4	6	M				July, 49	Cured	
11	10	5	M	Intermittent till 7. Constant since.			July, 49	Cured	Also has bronchiectasis See text
50	5	10	M	+			August, 49	Cured	See text
8	6	10	M	Dry at 2	aet. 6 after measles		August, 49	Cured	See text
1	10	5	F	+			Sept., 49.	Cured	See text

TABLE III B. : 6 CASES.

CLASS II. AGED 3½ TO 10 YEARS WITH HISTORIES
SUGGESTING EITHER INCONTINENCE OR ESSENTIAL ENURESIS
COMPLICATED BY OTHER FACTORS.

CASE NO.	A G E		SEX	E N U R E S I S			TREAT- MENT START- ED	RESULT	COMMENT
	YRS.	MTHS.		FROM BIRTH	RE- LAPS- ED	ALSO DIURNAL			
34	4	4	M	+		+	June, 49	Cured	See text
28	5	6	F	+		+	June, 48	Failure	See text
33	3	10	M	+		+	June, 48	Cured	See text
51	4	7	M	+		+		Nearly Cured	See text
25	14	11	M	+	act. 5	+		Cured	See text
52	10	3	M		act. 5	+		Cured	See text

TABLE III C. : 23 CASES.

CLASS III. AGED GREATER THAN 10½ YEARS.

CASE NO.	AGE		SEX	ENURESIS			TREATMENT STARTED	RESULT	COMMENT
	YRS.	MTHS.		FROM BIRTH	RE-LAPSED	INTERMITTENT			
47A	13	3	M	Dry at 2	act. 3		August, 48	Cured	
42	12	-	M	+			Sept., 48	Cured	
38	13	-	M	+			Sept., 48	Cured	
19	28	-	F	Dry at 2	act 5½	+	Sept., 48	Cured	See text
2	14	-	M	+			Nov., 48	Cured	See text
7	11	10	M	+			Jan., 49	Not cured	See text
17	17	1	F	+			March, 49	Cured	See text Treated at R. A. H.
26	11	-	M	Dry at 18/12	act. 5 after burns and asthma		Feb., 49	Cured	
24	17	6	F	Dry at 4	act. 7 after measles		Feb., 49	Cured	Treated at R. A. H.
30	11	8	M	Dry at 18/12	act. 3	+	Oct., 48	Cured	See text
35	21	5	F	+		at times	Dec., 48	Cured	See text
21	12	7	M	+			April, 49	Cured	Treated at R. A. H.
45	17	7	M	Dry at 16/12	act. 7		June, 49	Almost cured	See text
43	13	8	F	+			June, 49	Cured	
48	11	2	F	+			June, 49	Cured	See text
23	12	5	M	+			July, 49	Cured	
29	11	9	M	+			July, 49	Cured	

TABLE III C. (Contd.)

CLASS III. AGED GREATER THAN 10½ YEARS.

CASE NO.	AGE		SEX	ENURESIS			TREATMENT STARTED	RESULT	COMMENT
	YRS.	MTHS.		FROM BIRTH	RE-LAPSED	INTERMITTENT			
9	11	1	M	+			July, 49	Cured	See text
53	38	3	M	+			Sept., 49.	Cured	See text
49	11	10	M	+			Sept., 49	Probable failure	See text
54	24	-	F	+			Nov., 49	Cured	See text
73	24	7	F	+			Nov., 49	Probable cure	See text
72	13	2	M	+			Nov., 49	Cured	Continent subsequently

Individual Results and Discussion.

Patients in the three Classes are referred to in the numerical order of their case numbers. Some of the successful cases are not detailed as there are enough described in the following pages to indicate the usual progress and the supervision which is necessary. All patients who were not cured are described.

Brief Case Reports from Class I:

Case 1 - A female aged 10. 5/12 years. She did not wake on the first night when she received the stimulus, and yet did not continue urination, i. e., the stimulus produced inhibition without waking. The parent had to wake her, after which she passed 12 ounces of urine. She became continent after $3\frac{1}{2}$ weeks when her bladder volumes were of the order of 20 ounces or more. She is of interest, in that it was almost impossible to make her take sufficient fluid to make it imperative that she urinates during the night when once she developed bladder inhibition. Generally, I have not been content to consider the patients cured until they will wake regularly with a large fluid intake. She has not had a wet bed in the $3\frac{1}{2}$ months since treatment and has woken of her own accord on at least 3 occasions to urinate during the night. On the first occasion she was heard to be crying slightly, yet was not properly awake. Despite the pain of a full bladder she remained continent

until fully awake and then passed over 30 ounces of urine. In the preliminary day and night tests 9 ounces was the greatest volume recorded. She has been away for holidays since treatment.

Case 4 - A female aged 3. 8/12 years was referred on by a paediatrician. She had enuresis at least twice a night usually. She became continent after 13 nights and has remained so. Two weeks after treatment, she developed pneumonia and was ill for a fortnight, but even under this stress she was continent.

Case 5 - A female aged 6. 3/12 years had enuresis once or twice a night regularly. After 15 nights she became continent and has not had a single wet bed in the ensuing 6 months.

Case 6 - A male aged 7½ years. For the first 6 nights he did not wake on urinating but he inhibited micturition from the effect of the stimulus which was not sufficiently intense to disperse sleep. His parent had to wake him, after which he urinated. The stimulus was then increased to wake the boy, but at no time did it distress him. He took 5½ weeks to attain complete continence.

Case 8 - A male aged 6. 10/12 years. He was continent at two years and remained so for four years.

He relapsed immediately after contracting measles ten months before treatment. He soiled the bed regularly twice a night. The maximum volume at micturition during investigation and early treatment was 5 ounces, most volumes varying from $\frac{1}{2}$ to $3\frac{1}{2}$ ounces, so that he showed signs of reversion to an infantile bladder. At the completion of treatment which took $6\frac{1}{2}$ weeks, he was dry all night and passed 8, 10, 12, 11, 10 and 8 ounces on the last six nights when he wore the belt. He has had only one wet night in nearly four months since. He is "thrilled" to be able to get into his parents' or brother's bed, and no longer fabricates stories to explain why he is not wearing the pyjamas which he used to soil, dispose of on waking, and then don a new pair.

Case 10 - A female, aged 9. $2/12$ years, was the eldest child of a doctor with 2 younger children who were continent before two years of age. She, being the first child, had intensive so called training and many forms of treatment. She showed evidence of a well established delayed response causing enuresis as well as immediate conditioned responses to noise and light, so that she had enuresis usually twice a night. She became continent in 10 days. Four months later she suffered a severe relapse of eczema

which caused three wet beds in four nights. She then used the apparatus for five nights, experiencing three reinforcing stimuli, and regained continence despite the ensuing weeks of severe eczema (of which several mild attacks have since occurred). Six months later this child was the victim of a measles epidemic in Adelaide, and during the acute febrile stage she had three wet beds. On recovery, with a copious fluid intake, she received one reinforcing stimulus only. During the period of over a year since then she had been for holidays, on board ship, and enjoys a very full life and has had only one wet bed. In the light of observation and experience, I think that the second reinforcement was unnecessary. Other children have had similar mishaps under the influence of illness or stress and have continued to be continent afterwards.

Case 11 - A male aged 10. 5/12 years, had regular enuresis, usually twice a night. He received 16 stimuli in 21 nights and trebled his apparent bladder capacity. He has had four occasional wet beds since treatment. He was able to go for a fortnight's holiday away from his parents and was dry. His parents state that he has become much more happy and tractable and is progressing better at school. His history

revealed that he had been terrified for fear that his defect should be revealed to anyone.

Case 13 - A male aged 9. 8/12 years had enuresis twice nightly, passing $3\frac{1}{2}$ ounces of urine or less each time. He received 15 stimuli in 13 nights, after which he was continent all night, passing 8 to 9 ounces of urine on waking. He remained continent and went for two weeks holiday. A few weeks later, he began to have occasional enuresis which became more frequent. Reinforcement was given two months after the first treatment, by forcing the fluid intake, and sending him to bed early. He wore the belt for 13 days but received only five stimuli in this time. He has since remained continent.

Case 14a - A male aged 6. 5/12 years, started treatment at the Adelaide Children's Hospital and completed it at home simultaneously with the brother, Case 14. The parents consider both cured, although there has been a rare wet bed in each case.

Case 15 - A male aged 10. 4/12 years, lived in Canberra and had intractable enuresis. At the request of a member of the National Health and Medical Research Council, a unit was flown there for treatment. He received 21 stimuli in 5 weeks, becoming continent after forcing his fluid intake at night.

Case 16 - A female aged 5. 1/12 years, was the only child of a medical practitioner who had tried almost all types of treatment, including atropine, ephedrine, luminal and antuitrin-S. The child was highly nervous and terrified of the idea of treatment so that her confidence had to be won by her parents. The first night that she wore the belt, she was dry for the first time in her life. Thereafter, she received 11 stimuli in fourteen nights. On only one occasion did the father observe signs of the child being aware of the stimulus and yet urination was arrested. Each time the parent would switch off the unit before the child woke and yet the inhibition of micturition would persist until the child was awakened by a parent. On the sixth night after the last stimulus, and after the use of the unit was discontinued, the child had a wet bed and was febrile. This proved to be the prodromal stage of rubella, but despite this, there were no more wet beds during the illness and the belt was not re-applied. This is one of the few examples where there was evidence of a transient effect on the first night as a result of suggestion, but, as in every other case, she relapsed immediately, so that the steady progress of extinction of compulsive ~~urinating~~ responses and the inhibition of detrusor activity were necessary for cure.

Case 18 - A female aged 8. 11/12 years was referred for treatment by a paediatrician. She became continent after one month, and her diurnal frequency and slight lack of control improved spontaneously after the cure of her nocturnal enuresis.

Case 20 - A female aged 6. 11/12 years. Three older siblings had all become continent before they could speak, i.e., soon after one year of age. She was always wet before 11 p.m. and usually once after that. After 8 stimuli received in 14 nights, she became continent without the need to micturate during most nights. She has not had any relapse.

Case 23A - A male aged 3. 9/12 years. The preliminary "urinary pattern" did not show a urinary volume of more than 4 ounces at any micturition, most recordings being 2½ ounces. He received 25 stimuli over a period of 22 nights, by which time his volumes at urination were 5 to 6 ounces. The last four stimuli were distributed over 11 nights during which he woke naturally to micturate on 9 occasions. After an aeroplane trip for a holiday he was very excited and wet his bed twice, for which he was given reinforcement treatment with increased fluid intake over a period of 9 nights. He now usually wakes once through the night and calls out that he wants to "wet", although with the warmer weather (summer) he has more nights without needing to urinate. With excitement and

fatigue he has an occasional wet bed which is not unexpected in a young child. Should these become repetitive, he can easily be dealt with again, the parents having been warned against allowing him to become adapted to the wet state.

Case 36 - A female, aged 9 years, became continent after 11 stimuli received in 25 nights. The last stimulus occurred after 7 dry nights. She remained totally continent for three months. During the next three months she has had on two occasions two consecutive wet nights at a weekend, when she has had excitement and fatigue. At present I have advised the mother to wait before trying reinforcement, as the longer that continence continues, the less likely is the child liable to have such lapses. Alternatively, one could try and produce one or two reinforcing stimuli after giving excessive fluids and encouraging conditions which would lead to fatigue. However, with some other patients, it has been impossible to provoke incontinence after such a lapse, even when the belt has been worn for ten days or more.

Case 41 - A male, aged 5. 1/12 years, was referred for treatment by a fellow practitioner. In 33 preliminary observations a volume of 2 1/4 ounces was the most recorded at any passing of urine. He showed clear

evidence of a repetitive conditioned delayed response to micturate. As indicated in his full chart which is given on the sample treatment sheet, his urinary volumes were 10, $4\frac{8}{16}$, $10\frac{1}{2}$, and $8\frac{1}{2}$ ounces for the last four nights, at the end of a fortnight of treatment when he was continent. Six months later he has not had a single wet bed.

Case 46 - A male, aged 6 years. His mother said that he had enuresis 4 to 6 times a night which statement I doubted at that time. He had had much training and treatment in the past. He had suffered tonsillectomy, and had had a meatal ulcer and a perianal sinus operated on in hopes of cure. He was the second patient treated and showed dramatic results. This child used to ride a bicycle to my home each night carrying his sheets and night attire for treatment, returning to his home each morning. He received 5, 4, 2 and 1 stimuli on consecutive nights. On the sixth night he was continent, not passing urine all night so that his bladder showed an apparent 400% increase in capacity. Six nights later, in cold weather, he was made to drink over a pint of water on going to bed. At 3.45 a.m. he awakened crying but continent. At first he disclaimed desire to micturate and was made to do so when I realised that probably this was the first time

in his memory that he had had a bladder full enough to give acute "bladder discomfort". Obviously, he did not refer his sensations to the necessity for emptying his bladder. After 8 nights, he was continent, and virtually remained so having his first wet bed some months after treatment and 3 other such wet nights in the next 10 months. He then fell victim to a measles epidemic, and relapsed. In this case I waited to see if he would regain continence, but he became an irregular enuretic. It seemed that some of the older compulsive responses were reactivated, exemplifying that long established responses have a more persistent survival than recently acquired ones. He then had a week of treatment, which sufficed to cure him. He has remained continent for the past year.

Case 47 - Aged 3. 10/12 years, a brother of the Case 47A, was treated at the same time. He received 19 stimuli in $7\frac{1}{2}$ weeks. During the following year he was totally continent despite measles and other illnesses. In the next six months he had an occasional wet bed, but woke immediately on such occasions. In the last three months he has not had a wet bed.

Case 50 - A male, aged 5. 10/12 years, was the first of two male children of a medical practitioner who had to go to England in the near future and who had tried

several forms of treatment. The "urinary pattern" and early treatment showed the child to have a two-hourly frequency by day and night with average bladder volumes of 2 ounces. He received some 48 stimuli in 5½ weeks and became continent. At first he had enuresis 5 times a night, apparently from repetitive conditioned responses. The stimulus steadily brought about an extinction of these responses and the inhibition of the detrusor muscle began to build up. For the last fortnight of treatment he showed evidence of being converted to simple enuresis in which he would not wake when the bladder was full. Subsequently, the inhibition of the detrusor was built up to become prepotent over the bladder reflex so that he woke with the discomfort of a full bladder and passed amounts of 12 to 14 ounces of urine which equalled the total volume which he used to pass in a night with hourly frequency. One can well understand why it was thought that such children passed a voluminous dilute urine. The results of the "urinary pattern" and treatment are the only means of finding the true state of affairs. Five weeks after treatment he had two consecutive wet nights. On the first I advised to watch for a febrile illness and on the second night he had a "cold". Two days later he fell over and suffered severe lacerations to the hands, experiencing

a wet night on that occasion. He did not have reinforcement and was still dry when the family and he embarked for England.

Brief Case Reports from Class II.

Case 25 - A male aet. 4.11/12 years, had poliomyelitis some fifteen months before and at night wore a lower spinal brace which was always saturated with urine. As a consequence, he had a severe urine rash. He had diurnal enuresis at times and unfailing nocturnal enuresis, several times a night. He was found to have small diurnal volumes, and with his poliomyelitis history, there seemed a probability of a complicating neurological defect so that he did not fit the category suitable for this treatment. He was referred for trial treatment by the Adelaide Children's Hospital where he was admitted. However, at the end of five weeks' treatment, complicated by an intercurrent illness, he was quite continent and his buttock rash was healed. He still had to wake and micturate at least once a night. At this time his mother was ill so that he was sent to a convalescent home. For a further 3 weeks he was continent, but at the end of a month when he went to his home, his mother found that he was enuretic again. The child's story that there was no night staff at the convalescent home was confirmed. The weather was very

cold so that the child, who still had to micturate through the night, began to do so in the bed after awakening and had factitious enuresis which caused a relapse into true enuresis. The attendant difficulties due to the spinal brace were by then complicated by furunculosis. The mother delayed reporting the relapse, in the hope that he would spontaneously recover, but by then he was urinating in sound sleep and could not waken although the mother was prepared to attend to his wants. He was re-admitted to hospital for further treatment but had to be discharged immediately owing to an outbreak of infectious diseases in the wards. At this stage, the parents were too nervous to institute treatment at home, the mother having had a "nervous breakdown" shortly beforehand. Ultimately the mother agreed to treat the boy at home, by which time he still had almost regular nocturnal, but not diurnal, enuresis. After 13 reinforcing stimuli, received in 8 out of 13 consecutive nights, he was waking naturally. Usually he had to micturate once during the night after calling his mother and retaining up to 8 ounces of urine, with complete continence.

Case 28 - A female, aged 5 years, was treated at the Adelaide Children's Hospital. She had constant diurnal and nocturnal incontinence and occasional encopresis.

The child would not talk to adults or to children in the ward. There was doubt as to whether the child was subnormal or was suffering from a psychosis. The parent stated that the child was "different" from the other children. When tested the child showed no evidence of paralysis or anaesthesia. She showed obvious awareness of a mild stimulus such as a pinch or pin prick. After 3 nights of treatment the child showed, at the site of stimulation, some areas of electrolysis which necessitated simple therapy and interrupted treatment of her enuresis for a fortnight. The nurses were emphatic that the child had not called out and older children in the ward substantiated this assertion. Unfortunately, on one occasion the night nurse had to be out of the ward for some minutes and found the instrument signalling on return. At this stage investigation showed that the child would not make an outcry from any type of stimuli which could be expected to produce pain, although she had perception of the stimulus (pin etc.) as far as we could determine. Armed with this knowledge, and with the careful co-operation of the staff, it was decided to examine her response to treatment over a period of 3 weeks. She still would not call out, but on nearly all occasions she would arrest the act of micturition and wait for the nurse. At the end of the term, she had no encopresis or

diurnal enuresis. On three out of the last four nights she was continent, waking to micturate. In view of the extreme care needed, she was discharged with a verbal and written message to the parents, inviting them to continue treatment at home if necessary. She lives 50 miles from the city and no further news has been received. She has been listed as a failure, but her response was most interesting. If possible her future progress will be recorded on another occasion.

Case 33 - A male, aged 3. 10/12 years, was admitted to the Adelaide Children's Hospital for treatment by the Medical Superintendent. On admission it was believed that he had only nocturnal enuresis and that his mental age was normal, so that he was treated at night only. Immediately it was obvious that he had diurnal enuresis with hourly frequency of volumes varying up to 3 ounces, with a rare 4 ounces. At this stage there was some doubt as to his mental development. As an experimental measure he was kept in his cot and wore the apparatus by day as well as by night. At the end of a fortnight he was retaining up to 7 ounces of urine. Two to three hours would elapse between micturation, most of which occurred under full volition. At the end of five weeks, he had become

continent by day and dry most nights, waking when necessary. His improvement in volume and reduction in frequency were maintained. His family regard him as cured but for some months he had occasional wet beds.

Case 34 - A male, aged 4. 4/12 years was referred for treatment by a paediatrician and had nocturnal and diurnal frequency, with such small volumes on micturating that he appeared to have a neurogenic incontinence or else a congenitally small bladder.

The following are average samples of his preliminary test volumes:

Daytime: $1\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, $1\frac{1}{2}$, $1\frac{1}{2}$, $1\frac{1}{2}$, 1 ounces. Night time: $1\frac{1}{2}$, $1\frac{1}{2}$, $\frac{1}{2}$, $1\frac{1}{2}$, $\frac{1}{2}$ ounces. As indicated the night volumes are similar to the day volumes when he had none of the restrictions which were necessary to record the night urine, so that they may be taken as accurate. He did not wake when the night samples were passed and collected by the method already described. Because of the experience with Case No. 33 and at the request of the parent and doctor, this patient was started on treatment, realising that he did not belong to the category for which this method was designed. Although he had diurnal incontinence at times, he was not treated in the day. After three weeks of treatment, he was re-

taining amounts of urine up to 10 ounces and on one occasion 14 ounces. This great increase can only be explained on the assumption of an increased inhibition of the bladder or else the removal of compulsive impulses to urinate or a combination of the two. In such a short time, no development in innervation could occur nor could there be an anatomical increase in bladder capacity. The boy's diurnal enuresis became much less in the same period of time and despite an intercurrent acute febrile illness in the fifth week of treatment, nocturnal and diurnal continence were established after six weeks. Ten weeks later continence was still maintained, the father promising to report if the child relapsed.

Case 51 - A male, aged 4. 1/12 years, is another of the most interesting ones. He had always been an extremely "wet" child, becoming worse if anything after an attack of poliomyelitis when 2 years of age. The child was referred on by a senior paediatrician and was a formidable problem. He had diurnal and nocturnal enuresis, frequency 5 to 6 times a night. The following is a sample of his "urinary pattern" (volumes in mls.) Day: 40, 40, 48, 50, 42, 58, 78, 44, 46, 76, 46, 38; Night: 24, 30, 28, 46, 22, 78, 54, 44, 44, 26. Thus he had hourly frequency day and night, together with precipitancy. Despite the lack of

obvious paralysis or perineal anaesthesia, the possibility of a lesion from poliomyelitis had to be borne in mind as well as other causes. The parents were both highly intelligent and very willing to co-operate when the position was outlined to them as being an experiment. They have kept a complete night record for the ensuing 8 months. The following is the record of four consecutive nights after five weeks of treatment; 1st night he slept dry all night, passed 174 mls. on waking at 7.10 a.m.; Second night; Woken by stimulus at 11.05 p.m., passed 104 mls.; woke naturally at 5.35 a.m., passed 100 mls.; woke naturally at 7.45 a.m. to pass 130 mls. with good control (i.e., no great precipitancy); Third night; Woken at 1.5 a.m. and 3.45 a.m. each time by the stimulus to pass 102 and 92 mls. respectively; woke naturally at 7.15 a.m. to pass 120 mls.; Fourth night; Woken by the stimulus at 4.30 a.m. to pass 182 mls; woke naturally at 8 a.m. and passed 82 mls. of urine. At the end of two months he was urinating 2 to 3 times a night usually and passing volumes of urine ranging between 140 and 170 mls. on most occasions. Between the eighth and eleventh weeks (23 days) he was woken by the stimulus only six times. The apparatus was not used from time to time. Since then, he has had to urinate once at least through the night. For months he would have about 2 wet occasions



a week, sometimes going a week or more without a wet bed. As soon as two or three wet beds appeared, or if he wet the bed and did not wake immediately with the discomfort of the wet state, the parents gave him some nights of reinforcement. The child did not fear the apparatus and the parents took care that the stimulus was kept to the minimum necessary to wake him when he micturated in sleep. With parental encouragement, the child adopted the attitude that he was helping medical work. For some time the parents have been making sure that the boy wakes up when they go to bed at about 11 p.m. -- He micturates voluntarily and then can go through till morning, remaining continent on about 4 out of 5 nights. When he does wet the bed it is nearly always just at the time of waking in the morning. He illustrates that where there is frequency and precipitancy, it is difficult to establish and maintain continence. Fatigue, excitement, and increased fluid intake at night will all tend to produce wet nights, leading to the probability of relapse into constant enuresis. With care and reinforcement when necessary for the next few years, I believe that this child can be protected from life-long enuresis.

Case 52 - A male, aged 10. 3/12 years, was the son of a doctor who lived in India. He was continent at eighteen months of age and until five years of age when he had

measles in Adelaide while living away from India. On his return to his parents in India soon after, he was found to be enuretic. His I.Q. was 170 and he came with a family history of brilliant attainment but tending to psychopathology. He was extremely "nervy" and constantly chewed his finger-nails. His mother noticed that he was clumsy with fine co-ordinated movements. His father was intolerant of his affliction of which the boy was most sensitive. He was so hard to wake during the night that it was impossible to get him to talk sensibly or show signs of comprehension. He had urgency and precipitancy and apparent diurnal enuresis or incontinence at times. His treatment was twice interrupted unavoidably, and he had one course of reinforcement. At the end of reinforcement, he had full daytime control but evidence of urgency. At night he woke readily to micturate, but had precipitancy so that, although he woke before micturition, he sometimes had a damp patch on his pyjamas before he could attend to his wants. However, he does not have a waterproof now and the mattress does not get soiled. Temperamentally, he is much better and has ceased to bite his nails. He has much more confidence, and as a result of his virtual cure of enuresis, he is very friendly with his father.

Brief Case Reports from Class III:

Case 2 - A male, aged 14 years, was referred by the medical attendant of the father who had tuberculosis. The boy was very sensitive about his condition and proved hard to cure. He received 27 stimuli in six weeks and then went for a holiday Interstate seemingly cured. On return he was extremely tired and drank a lot before retiring. That night he was wet and for some months was liable to bursts of relative enuresis for which he had three separate short courses of reinforcement. Since these he has been virtually cured, suffering one wet night every six to eight weeks.

Case 7 - A male, aged 11. 10/12 years, has been quoted before as having suffered severely from the consequence of enuresis. This was aggravated by the father's attitude to him. The boy resented treatment for fear that it represented further punishment. A disastrous start was made with the treatment, as I discovered later. The father, against all instructions, began the first night by greatly increasing the stimulus and short-circuiting the unit, so that the child received frightening stimuli before going to sleep, the father threatening him with more such treatment if he did not become dry. As a form of suggestion the process was a costly failure, for the child always resented the instrument,

even after he had told me the story and I had censured the parent (for which I suspect that the child received more punishment). After 7 weeks he discontinued the use of instrument, being continent for nearly a fortnight. Subsequently, he continued to have irregular wet beds despite one attempt at reinforcement, so that he was 30% as bad as he was before treatment was instituted.

Case 9 - A male, aged 11. 1/12 years. He received 19 stimuli in 20 nights, at first experiencing two a night, before acquiring continence. He had one wet bed 3 weeks after, but none in the ensuing six months.

Case 17 -A female, aged 17. 1/12 years, was referred on from the Outpatients Department of the Royal Adelaide Hospital. She had proven spina bifida and a mental age of about 10 years with great irresponsibility. The parents and siblings were normal. She had worked in 17 positions in the preceding 18 months. Treatment was started in hospital and continued at home, but the girl was most un-cooperative and at times would not wear the belt, or else would switch off the instrument before going to sleep. She did not use the apparatus during menstruation as the

female electrode then in use could not be used at such a time. Despite these difficulties, she was practically continent at the end of three weeks. During the next two months she had one wet night on each of two menstrual periods. She then agreed to drink copious fluids and use an instrument during the next period as a result of which she received two stimuli. Since then she has been continent experiencing about one wet bed every three months. She has become more tractable at home and has kept to the one occupation. She has lost her morning churlishness which she had on arising with a wet bed and soiled person.

Case 19 - A female, aged 28 years, was continent at 2 years, but relapsed on attending school. She had foregone matrimony because of enuresis, becoming a career woman, and living alone. Occasionally, she would be continent for a week but usually had two to four wet beds a week, despite retiring late, fluid restriction and treatment. Fatigue and excitement increased liability to enuresis, but most of it was unpredictable. She did not wake up when she wet the bed. She used the instrument for nearly two months continuously except during menstruation. Despite a large fluid intake at night, she soon

received stimuli only once in two to five or more nights. Consequently extinction of responses to urinate was slow and uncertain. For the two months ensuing after treatment, she was continent and then began to have relapses from once in 11 weeks to twice a week. In August, 1949, she had a reinforcement course receiving 12 stimuli in that month. At this time she was also undergoing treatment for possible thyrotoxicosis. She then decided that she would try to be a missionary, which meant going interstate in 1950. Of her own accord she tried a further reinforcement in November-December, 1949, but despite wearing the belt constantly for five weeks, she received only one stimulus. On all other occasions she woke easily before micturition. This patient, like some of the other older ones, had managed the whole of the treatment alone. She illustrates how difficult it is to extinguish permanently a long established conditioned response when stimuli for extinction cannot be regularly applied.

Case 24 - A female, aged 17. 6/12 years, had been continent from 3 to 5 years of age, relapsing into enuresis after whooping cough. Without fluid restriction and a late retiring time she would wet

once or twice through the night. Treatment was commenced at the Royal Adelaide Hospital, and finished at home. She became permanently continent after three weeks in all. She now wakes readily for the purpose of micturition or for any other reason, whereas before treatment she was difficult to wake and would not waken even after the discomfort of a wet bed. She is of interest, in that she did not wear the apparatus during menstruation. This did not retard her progress.

Case 30 - A male, aged 11. 8/12 years, had irregular enuresis two to five times a week with a rare interval of two to three weeks of continence. His history and "urinary pattern" suggested the simple form of enuresis complicated by occasional conditioned responses as well. He was rather refractory in establishing continence and several nights would elapse between stimuli. For some time after ceasing treatment he had an occasional wet bed. Four months and twelve months later he reported that he was continent.

Case 35 - A female, aged 21. 5/12 years, was referred on by a psychiatrist after having years of varied treatment. She later admitted that she avoided entering matrimony because of the affliction. As a child she had been subjected to intensive training. She received

9 stimuli in 25 days, and did not use the apparatus during menstruation. She has remained continent, and as a result she obeyed the dictates of her heart by becoming engaged and it is understood that she is now married.

Case 45 - A male, aged 17. 7/12 years still had enuresis on four to five nights of the week. He had great trouble, through his affliction, at boarding school and at home where his parents were almost desperate about him. He stated that he worried about enuresis every day of his life and wondered how he could stop it. He had developed stammering and had lost confidence in himself. His last examination results were poor compared with his previous good record. A vocational guidance officer estimated that he was fit for manual or shop assistant type of work. After three weeks of treatment he became continent for several further weeks. He was not co-operative in treatment and he would not keep accurate records for the month. His parents state that he became continent for some weeks and then began to relapse on occasions. Four months ago he voluntarily requested further treatment and has co-operated in the regime. He received two stimuli in the first week, but then he had only one in a

month. His parents report that he is becoming more tractable in the home so that his co-operation will probably persist. After the results with other young adults, I consider that continence can be maintained.

Case 47A - A male, aged 13. 3/12 years, was an irregular enuretic. During treatment he received 13 stimuli in six weeks. He then remained continent except for a wet bed about once a month when he was excited and very tired. He has been totally continent for the last seven months.

Case 48 - A female, aged 11. 2/12 years, was referred for treatment by a general practitioner. Treatment was started 16.6.49. and the following is a copy of a comment I made on 17.7.49:- "Note that till now there has been a "triggering" mechanism and urination has not been related to necessity. In the early stages the amounts varied from 6 to 12 ounces. Now that the bladder is uniformly nearly full one hopes that the final stage requiring inhibition to wakefulness will be acquired. Evidently until now the process has been mainly the inhibition of noxious conditioned responses to urinate". Altogether she received 24 stimuli in six weeks. She was continent for the next 12 nights passing 12 to 14 ounces on every occasion that she woke through the

night or in the morning if she had not woken during the night. In the following week she had two wet beds, but none since. The potency of the discomfort of the wet state to disperse sleep immediately after urination, had been maintained without reinforcement in this patient; had adaptation to the wet state occurred, presumably she would have relapsed to the extent of urinating in sleep when her bladder became full during the night.

- * Case 49 - A male, aged 11. 10/12 years, had enuresis unceasingly, wetting the bed twice a night. He had received various treatments and was sent by a consultant for this treatment. His anxiety about the condition was altering his personality. He was "growled" at both at home and at school where the quality of his work was falling off. At night it was virtually impossible to wake him to a state of comprehension. During treatment he resented being woken by his mother or the instrument. He had two months of continuous treatment, during which he would arrest the act of micturition at the onset of the stimulus, but would not wake. At the end of this period he woke of his own
- * He is now at boarding school apparently cured. His younger brother aged four years, and not included in the list, was cured with this treatment in two weeks.

accord to micturate at night on three occasions, the first such that the family could remember. He had periods of continence for a week or more with intermittent relapses. He has proven the most resistant patient so far in terms of raising bladder inhibition to such a potency that sleep will be dispersed by the discomfort of a filled bladder before micturition occurs. If necessary, it will be worthwhile trying a stimulant drug in conjunction with this treatment. I am presuming that his narcosis-like sleep has developed from his unremitting soiled state since infancy.

Case 53 - A male, aged 38 years, was married with three children. He had nightly enuresis in the winter. In summer he varied in the number of wet nights per week. He was treated during cold weather and rapidly eliminated his 11 p.m. enuresis which he had had from childhood. This appeared to be a firmly established delayed conditioned response. He had also an occasional later enuresis that could not be ascribed to a known cause. During the latter part of treatment he frequently went a week or more without enuresis despite a high fluid intake. For the last three warm months he has been continent

and we await next winter to see if further reinforcement will be required.

Case 54 - A female, aged 24 years who was already separated from her husband, has been previously described under the consequences of enuresis. She was referred on by a medical consultant. After a week of treatment receiving two or one inhibiting stimuli a night, she was continent for 12 nights before receiving what proved to be the last stimulus. During this time she took extra fluid at night so that she had to wake to urinate every night. She flew back to her home in Tasmania for the latter part of the treatment as soon as she understood the full regime. Her last report was total continence for 13 weeks, and that she would notify any relapse. She is of interest, in that before and since treatment the greatest volume of urine recorded in the day-time at any urination even if imperative, is 3 ounces. She has always had frequency. Since treatment, she retains up to 10 ounces of urine during sleep without causing much discomfort, so that it appears in her case that at present much more inhibition of detrusor activity is possible in sleep. She also illustrates the fact that frequency and enuresis are separate entities, although frequency is liable to lead to enuresis for the reasons elaborated in the discussion.

Case 73 - A female, aged 24. 7/12, whose home was in Canada had always been anenuretic. She was a well-educated woman. She left her family and also the problem of matrimony some months before. She had had much treatment ("thousands of dollars") and was referred to me by a consultant. Her reaction to the affliction has been described under the consequences of enuresis. After so much other unsuccessful treatment, she was sceptical of success but willing to carry out this method, managing all details alone. In fact part of the treatment was carried on while she went on a month's holiday with a tourist service, travelling through three States. She was armed with a letter from me so that she could have single room accommodation during tour. She took six weeks to attain reliable continence. Since then she has been almost uniformly continent, and has decided to return to her home. She confesses that she can now consider matrimony, whereas she had previously decided that she would not marry because of the affliction. At present she is forcing fluid intake at night, with the intention of establishing a high level of continence prior to embarking for home, having already booked her passage.

Relapses and the Onset of Enuresis after early Continence.

Fear, excitement, fatigue, emotional upset and other disturbances of environment such as the first attendance at school, all of which have been invoked as direct causes of enuresis, are known to produce occasional enuresis in many otherwise continent children, but a small minority of children relapse into a state of enuresis at such times. I consider that the evidence of this investigation favours the view that such factors interfere with the nervous integration, especially the "analyser" function, essential to establish or maintain a sufficiently high level of inhibition, and not that the child voids from volition. The supervening enuresis may thus affect a child who has or has not been continent from a very early age.

The numbers of this series are too small to make a final classification of such cases, but it appears from the "urinary pattern" and histories that two variations may be seen in those cases where there has not been preceding enuresis.

In the first variation the inhibition of the detrusor seems just not enough to allow the bladder to fill sufficiently to cause awakening. Prior to treatment, fluid restriction or hot weather may permit the patient to be continent. The patients give the signi-

ficant history, however, that even when continent at night, they never wake to pass urine. After treatment, the amount of urine passed does not show much increase over what had already been satisfactory.

In the second variation, the level of "tonic" detrusor inhibition appears to be depressed, so that micturition results from relatively small volumes, as a result of which, enuresis may occur two or more times a night. In both types, this form of treatment produces a restoration to continence fairly rapidly.

When there has been a relapse due to the above-mentioned factors with a history of a preceding well established enuresis the "urinary pattern" suggests that, with the removal of inhibition, some of the older established conditioned responses to urinate have become reactivated, apart from producing the variations just described.

Over a period of years, it has been noticeable that an acute febrile illness, especially measles, causes enuresis, either as an isolated phenomenon, or as a fully developed state. An attack of hay fever (Gaudin, 1941) or an irritable condition of the skin, has been observed by other authors to have similar effects on occasions. Examples of all these were seen in the present series

of patients. Here again, I believe that suppression of inhibition is involved in producing enuresis. During treatment by the method described in this paper, there have been several occasions when one could predict a febrile upset towards the end of reinforcement, for as long as two nights before obvious clinical diagnosis, by the sudden re-appearance of what appeared to be primitive uninhibited bladder activity.

It is possible that emotional stress acts via the cortico-hypo-thalamico-cortical facilitatory pathway (Murphy & Gellhorn, 1945) resulting in a decreased threshold for intra-vesical pressure to initiate the reflex micturition as well as by interfering with "analyser" function.

There has been a tendency to explain many of the phenomena described in this paper on the basis that they represented active volitional urination of psychological origin, but to me this is not the explanation of the various "urinary patterns" which are found. Added to this there is in this series no record in their past histories of patients either wetting the bed while awake or remembering any dream of the act. During treatment and after, some patients have volunteered the information that they have

dreamed of passing urine and have woken with a start to find the act just inhibited or even continuing.

There is a reasonable explanation why factitious enuresis can lead on to a secondary true essential enuresis. A child may urinate in the bed while awake from psychological volition, or because, when he wakes to urinate, he is afraid of the dark or dislikes getting cold. As a result, he is in danger of becoming adapted to the resultant soiled state. Such adaptation would lessen the potency of the "somatic discomfort" as a factor tending to inhibit micturition, or to awaken the child so that there is the possibility that the child will soon urinate in sleep and remain asleep especially if factitious enuresis is repetitive as may happen in a cold winter. When essential enuresis is established as an outcome of such practices, the child is just as incapable of arresting it as if it had been the original condition. While such a secondary type is able to be treated effectively by the method described in this paper, it is desirable to adjust the contributing factors in order to hasten the conversion to continence and to guard against a subsequent relapse (See Case 25).

Toilet Training in Child Management and Enuresis:

The histories of many continent children, irrespective of past enuresis, show that they acquired continence in the summer. This exemplifies that several consecutive dry nights, arrived at by any means, may be successful in removing adaptation to the wet state, so that the potency of the soiled wet state is re-established to produce two effects, i. e., to inhibit the act of micturition, and to cause wakefulness.

Mammalian young, such as kittens and puppies, are kept scrupulously clean by their mothers. This cleanliness must tend to keep a contrast between the dry and soiled state and thus maintain the potency of the factors which have been described as necessary for the natural conversion from incontinence to continence. I am convinced that the satisfactory basis of human training lies in maintaining this contrast between the dry and wet state (or the soiled state in the case of defaecation) by prompt attention to the infant's needs. Later, when the child has understanding, he should be encouraged to practice inhibition of detrusor activity during the day. Beyond this, I think that natural conversion to continence triumphs over so called training, but in the past the latter,

unfortunately, has received the credit, and leads to more vigorous efforts when the child remains wet. In fact, it seems that these efforts not only fail in their object, but when persisted with, actually aggravate the condition and reduce the possibility of natural recovery.

It is the author's opinion that the habit of "potting" children assiduously by day or night, especially when the child is not properly awakened, must tend to set up conditioned responses which initiate micturition. Noise, light and cold objects or even disturbance can become the conditioning stimuli for a response. These procedures usually take place at night and often during sleep when external environmental stimuli are reduced to a minimum. Pavlov found that he had to reduce external stimuli for the satisfactory establishment and maintenance of conditioned responses and that "analyser" function was not suppressed in sleep. Conversely, he found that disturbance of the external environment or emotional upsets usually produced a severe interruption of conditioned responses, even to the point of extinction. When the acts of "training" are repetitive after an interval of sleep, the circumstances approach those which are ideal for establishing a delayed response

which may itself be repetitive. The acts of urination so produced are not related to micturition initiated by a physiologically filled bladder.

The more a young child is disturbed at night, the more tired he becomes and consequently sleep tends to be deeper between disturbances. The majority of children treated in this series were extremely difficult to wake for many hours of the night. This deep sleep, amounting to stupor, almost precludes the likelihood of spontaneous cure so that a vicious cycle is set up. Rest, and an afternoon sleep will assist in some cases.

The study of the histories and the results of investigation and treatment in this series seem to the author to establish the validity of this view on training, which, if accepted, justifies a reconsideration of the recommendations for child toilet training.

Further Discussion in relation to the Results of Treatment.

The belief that most children with enuresis pass excessive quantities of urine at night is widely held by parents and doctors. In earlier years I had taken this for granted to such an extent that I wondered if some cortico-hypothalamico-hypophysial influence

affected urinary flow in many sufferers from enuresis. However, the "urinary pattern" shows that such is not the case. In this series, the night volumes were not abnormally large. A small amount of urine seems a great deal in a bed, especially when the child is found wet up to six times a night after changing the sheets and clothing. When handing in the results of the "urinary pattern" some mothers have said that these must be the first nights in years that the child had not passed "huge volumes" of urine, being unable to believe that the total volume passed in the night was not much greater than that recorded. The results also showed that there was a considerable variation in the amount of urine passed by a patient in either the day or night twelve-hour periods. The investigations and results have not supported the belief that noctilluria is even relatively common (Smellie, loc.cit., Bakwin, loc.cit.) or that a low specific gravity is associated with refractoriness to treatment (Fridall, loc.cit.).

Allergy is cited as an accompaniment or cause of enuresis, and it is of interest that the mother (a medical practitioner) of one boy (Case 52) noticed that asthma produced more voluminous urine.

Examination during an attack showed the volume of night urine to be nearly double the day (day: 345, 386, 365 ml.; night: 790, 620, 618 ml.) with the night S.G. ranging to 1019 and the day S.G. to 1020. This difference did not occur when he was free from asthma, which occurred more at night.

Pavlov found that the least number of stimuli necessary to establish a conditioned reflex was five and that most animals required between ten and forty. It is significant that the least number of stimuli to produce continence, and that in one patient only, was five, and that the majority needed some 15 to 40 stimuli. Experimentally a conditioned response, after extinction, is usually easily restored with fewer stimuli than were required for establishment, provided that there has not been long extinction and that there are no interfering factors such as illness, change in environment or neurosis. Experiences with relapses of enuresis show parallel results. In enuresis the rate at which inhibition becomes prepotent seems to depend on the duration of the responses which initiate micturition, the length of adaptation to the wet state, and the presence of

nervous tension. Nervous tension always in experimental animals retards the development of conditioned responses, more especially inhibitory ones. It is of interest to note that Pavlov (*loc. cit*) found that bromides and sedatives did not interfere with the establishment of inhibitory conditioned reflexes but did interfere with positive ones. Pavlov also found that neurosis extinguished conditioned responses and precluded the establishment of new responses and that bromide aided the restoration to a conditioned state. Experimentally, conditioned responses cannot be established in some animals, the failure most probably being due to past experience. Some breeds of the same species are known to be more refractory than others.

The results obtained by this treatment are remarkably parallel with the classical experiments on conditioned responses.

There have been other attempts to use awakening methods after micturition has occurred (Pfaundler, 1904, Genouville, 1908, Remy Roux, 1910). The most notable is that of Mowrer and Mowrer (1938) who used a buzzer which operated when a ped on the

bed was soaked with urine. These methods have been used either to see that the child is not left soiled or to superimpose a competitive positive conditioned response to wake at the time of urination. They have some time delay after the onset of micturition, and they utilize as conditioning stimuli, influences which are remote from the immediate "somatic discomfort" described in this thesis. After being aroused by the method or by an attendant, the patient is then cleaned, and kept dry. The design of the present treatment differs radically, in that it is intended to build up bladder inhibition so that the physiologically full bladder is the cause of the awakening which is the fundamental requirement for continence in my opinion.

In the investigation of male patients in this series the device used to obtain the "urinary pattern" was very similar in effect to that of the Mowrers' and was used for three to four nights. There was no indication of an inhibitory response to it and all the patients came on for treatment without any signs of amelioration as a result of its use. During treatment also, it happened

occasionally that, due to a fault in the stimulus lead, the instrument functioned with the light and buzzer active, but without a stimulus. In such cases the patients would not inhibit urination or wake unless near the end of treatment as has already been described. This was especially noticeable when for many days inhibition of micturition had been completely satisfactory in response to the electrical stimulus.

The widely held view that enuresis is a symptom and not a disease is reiterated by Batty (1949). I agree that the condition is not a disease, but I consider that essential enuresis is a physiological state and not a symptom. The psychological theory of the aetiology of enuresis may be stated as the belief that the child writes in urine his disapproval of his environment. On the occasion of preliminary communication to a scientific gathering a psychiatrist seriously stated that cure by the method described was dangerous, in that one method of expressing disapproval was eliminated, and that worse ones such as masturbation may supplant it. Far from exhibiting such tendencies, the patients have been uniformly much happier and show

behaviour that can only be interpreted as relief from tension, and not as repression. There has not been a single example of displacement to another avenue of expression.

Handled properly, this regime should produce no more mental trauma than premature awakening by any other practice for this or any other purpose.

Any method, relying on only one or very few stimuli, is not likely to be following the path of a conditioned response, but is relying on psychological suggestion and the maintenance of volitional control during sleep. In the literature there are reports that enuresis has been cured after one or more subcutaneous injections of sterile water (Friedall, 1927). It is notable that in this series there was no evidence of cure by suggestion. Considering the interview for a history, the investigation and the rather elaborate technique of treatment, one might have expected continence to be acquired forthwith, or within a day or two, by suggestion. Several of the patients were restless and woke of their own accord ^{ate} ~~to~~ ^{ate} within for one to three days from the beginning of treatment but all relapsed, becoming adapted to the new circumstances. They then proceeded to develop

continence in a manner which can only be compared with conditioned responses. Admittedly, most of these patients had been referred on by doctors after failure of treatment, or had sought advice because of such failure. Thus in over fifty consecutive patients, no cure, which could be reasonably explained by suggestion, resulted.

Many factors are described by those holding that the cause of enuresis is pathological (Campbell, 1937, Whinsbury-White, 1948). In this series no attempt was made to treat such conditions. Nevertheless, no cases in Class I showed any sign of refractoriness on this score. One patient with a meatal ulcer and two patients with vulvovaginitis became spontaneously cured of the conditions after continence was established, although the three had been treated specifically for these conditions in the past in the belief that the conditions were causal, not resultant. The urine rash, which is a common complication, clears up rapidly when once continence is established.

Although pathological and even neuro-muscular disturbances may exist in enuresis, they do not always preclude the possibility of continence being attained. Research work being continued at present shows that some such patients can become continent, but further work will be necessary to define the limits. A gross neuro-logical lesion will of course lead to irremediable incontinence. The diurnal history is of great importance in these cases, for it may reveal diurnal enuresis, precipitancy, and frequency associated with the passage of abnormally small volumes of urine.

The phenomenon that the majority of enuretic children pass small volumes of urine has been observed and studied, notably by Hallam (1950). Cystometrograms may show hypertonic, normal or hypotonic bladders

in enuresis.

It appears that the great increase in the functional capacity of the bladder after treatment can only be explained on the assumption that inhibitory impulses at the parasympathetic motoneurons of the sacral cord have become better organised, or that facilitation is diminished or that both mechanisms are involved. When enuresis appears after illness, injury or emotional stress the author believes that, in the vast majority of cases, it is brought about by a reversal of these processes and not by psycho-motor action. The recent studies and developments in the facilitatory and inhibitory nuclear centres and pathways show that there are cortical, basal nuclear and brain stem factors in facilitatory and inhibitory or suppressor functions (Murphy and Gellhorn, 1945; McCulloch et.al., 1946; Rhines and Magoun, 1946; Lindsley et.al., 1949). While it is not possible at present to do more than speculate on possibilities it does not seem unreasonable that some of the results detailed in this present work and many of the phenomena revealed by Pavlov, will be shown to depend upon these more or less automatic functions of the central nervous system.

The serious relapses with measles, such as that of Case 52, suggest that small lesions of the nervous system sometimes eventuate in the absence of clinical encephalitis.

There is usually a remarkable reversal of the waking habits of these sufferers. In this series, no history was obtained of any memory of the act of urinating at night. The majority of patients gave a history that they did not comprehend even simple instructions on being woken before treatment. Practically all of the patients after treatment showed a return to relatively easy waking with comprehension, not only for the purpose of micturition but also when awakened for other purposes.

Before instituting this method of treatment, a careful assessment of each patient is essential. Any congenital or acquired defects should be dealt with on their own merits and also as far as they affect the mechanisms described. I consider that it is impossible to assess any causal role of psychomotor activity in enuresis which has continued uninterruptedly from birth. I have not seen a relapse which appeared to be of psychomotor origin, but I concede that such is possible. I have insisted that psychological stresses are inimical to cure. Therefore, I believe that such stresses should be attended to, but only when there is indisputable

evidence of them.

No other form of treatment was used in this series in order to avoid confusion in assessing results. That is why intra-urethral and intra-vesical examinations were not made. However, I believe that adjuvant therapy is desirable at times in relation to the various mechanisms described. In the case of nervous and excitable children, sedatives such as bromide and barbiturates are indicated. Where sleep is so deep as to simulate narcosis, stimulants such as caffeine, ephedrine and benzedrine should theoretically aid the conversion process. For the same reason a late afternoon sleep, by lessening the depth of nocturnal sleep, may assist in developing inhibition to the point where it will allow bladder discomfort to exceed the threshold necessary to cause wakening. Bladder sedatives and anti-spasmodics such as atropine will, in appropriate circumstances, lessen the potency of the bladder-emptying reflex.

In the future adjuvant measures will be tried in the more difficult cases according to the various factors found operative. It should be interesting to test whether the milder cases can be converted any more quickly to continence, with the assistance of other therapy.

Nash (1949) concludes that enuresis is a developmental error in 70% of the cases, a view which is hardly compatible with an expectation of early cure in the majority of cases. The evidence of this series is that practically all cases of essential enuresis can be cured in childhood by an application of the principles herein described. It also appears that after the age of ten years a cure is slightly less certain for reasons which I hope have been adequately discussed in this paper, viz., that the complications of enuresis, especially those causing anxiety, become more prejudicial to cure with increasing duration of enuresis.

I cannot emphasise too strongly that a mild stimulus in most cases is adequate. In fact, many patients can be cured without the stimulus being enough to startle them from sleep.

Finally, it is strongly recommended that this method of treatment be first practised on some of the Class 1 children in order to gain experience of the different types of enuresis and the supervision to be adopted in the management of individual cases.

ADDENDUM.

Since preparing this thesis, some further relevant information is available with reference to treatment.

Case 7 is the only residual failure from Class III. Case 45 has been continent for some months now.

In Class I, three more children have had relapses, two being easily cured again, while the third has not yet been re-treated.

The next ten cases treated have all been cured. The only protracted case was that of the thirteen year old boy who is discussed in the section dealing with the consequences of enuresis upon the family.

GENERAL SUMMARY.

1. THE CONCLUSIONS AND RESULTS WHICH INTRODUCE
THE THESIS.

It seems certain that enuresis has always been a feature of childhood, and that in a small proportion of the sufferers, the affliction persists into adult life. The incidence approximates one in every four of the populace at three and a half years of age.

Incontinence of urine is universal in infants for the first months of life. During the second year of life there is a steep fall in the incidence of incontinence, so that by the middle of the fourth year, some three-quarters of all children are continent, and the residue by definition, are said to suffer from enuresis. This form of enuresis is by far the commonest. A small minority of children, after being continent for a variable period of time, relapse into a state of enuresis.

Many and varied views on aetiology have been elaborated over a period of centuries. The factors invoked in aetiology have embraced heredity, psychology, urogenital pathology, neuromuscular defects, remote local disorders, and systemic disorders of endocrine and other origin. A great variety of therapeutic measures has been practised.

Some of these measures have been based on aetiological considerations; some are still frankly empirical. None of these have been satisfactory, nor have they suggested that any one approximated to a specific cure. This lack of specificity throws justifiable doubt on the tenability of the theories of aetiology which hitherto have been put forward.

A study of the natural history of essential enuresis emphasises the seeming random distribution of incidence in the vast majority of cases. The statistical analysis of the present work in relation to the incidence in parents and siblings indicates that hereditary and familial factors are not significant. The analysis of the incidence of enuresis in parents and siblings does not reveal any significant difference in the sex incidence at an early age. Hence it does not appear that there is any basic difference in the causation of enuresis in the two sexes. The concensus of opinion is that in the older age group, males predominate. I consider that this is due to a greater persistence of the affliction in males. No other factors suggestive of an aetiological relationship were found in the histories and examinations in this research. Urinary examinations likewise did not reveal any positive significant features in this series. Internal examinations of the urogenital

systems were not performed, but any minor defects which may conceivably have been present, did not preclude cure. In three patients, urogenital defects were known to have existed, and to have been treated, before the present method of treatment was used. Not only did the earlier treatment fail to cure the enuresis, but the actual defects were not alleviated. They did however disappear spontaneously with the elimination of enuresis by the author's present method, so that it appeared that the enuresis was the cause of the irritative lesions, and not vice versa. All of this evidence strengthens the belief that the apparent random distribution of incidence is a real one.

It seemed very necessary to determine if possible whether there was a single specific basic aetiology for most enuresis, or whether there was a multiplicity of primary aetiological factors.

Many clinical observations suggested that nocturnal enuresis is directly precipitated by physical factors such as light, noise, and disturbance. Such acts of micturition appeared to be in the nature of conditioned responses. The histories of the manner in which patients had been "trained" in infancy, and the investigation of the "urinary pattern" gave additional support to the belief that

immediate and delayed conditioned responses accounted for much enuresis.

The "urinary pattern" of a patient is of great use in assessing the type of enuresis which is present. At the same time it is of value as an indicator of the difficulties likely to be encountered in treatment. When the urinary volumes are of normal values, the child after cure will probably sleep all night undisturbed. When the volumes of urine recorded in the "urinary pattern" are small this method of treatment may produce one of two results.

Firstly, the inhibitory tone may lead to a rapid increase in the physiological capacity of the bladder. This has been the more common result fortunately, for the patient can sleep all night undisturbed.

Secondly, the capacity of the bladder may remain small in which case the patient, although curable, is faced with the necessity of waking during the night in order to micturate. In children, especially during cold weather, this increases the danger of relapse considerably. There is already evidence that some patients in this category do develop greater bladder capacities slowly over a period of time so that the object is to treat any

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relapses immediately in order to maintain as high an inhibitory tone as possible.

GENERAL SUMMARY.

2. THE THESIS AND THE APPLICATION TO TREATMENT.

The author's opinion is that an understanding of the process by which urinary continence is attained in childhood is a pre-requisite before any theory of the basic nature of essential enuresis can be elaborated. This makes it necessary to assess the relative importance of the roles played in the process (1) by natural physiological activities, and (2) by artificial means, which include all forms of child toilet training and psychological suggestion. Experimental evidence, observations on infants, and observations on mammalian young support the belief that conversion from infantile incontinence to continence is usually attained by natural physiological processes.

In young infants a certain bladder tension initiates micturition. It is suggested that the skin is sensitive to the discomfort of being soiled with urine, and that at the onset of involuntary micturition, this "somatic discomfort" has an inhibiting effect on further micturition. Provided that the potency of this reaction is not diminished or extinguished, two separate developments would ensue from this

inhibitory reaction:

- (1) The bladder would gradually accommodate increasing quantities of urine before initiating reflex micturition. (This physiological capacity of the bladder will be further increased by the anatomical size of the bladder as the child grows).
- (2) The volume of urine tolerated in the bladder would increase until visceral discomfort would be produced. Provided that the inhibitory "tone" was sufficiently strong, the discomfort of a filled bladder would wake the child before reflex micturition was initiated.

The inter-reaction of four factors: (1) the depth of sleep, (2) the tendency of bladder tension to initiate reflex micturition, (3) the potency of the inhibition caused by the discomfort of the soiled state, and (4) the visceral discomfort of a filled bladder, would determine the end result from a steadily filling bladder during sleep.

For nocturnal continence it is necessary that the inhibition of the detrusor muscle should be predominant until a distending bladder causes sufficiently intense discomfort to dissipate sleep.

If however, the distending bladder initiates of micturition reflexly, before the person awakes, simple essential enuresis will be the result.

Repetitive enuresis, especially if the patient is left soiled all night, will lead to an adaptation and suppression of the potency of the inhibition caused by "somatic discomfort" at the onset of micturition. Fluid restriction, by reducing the volume of urine to less than the threshold value for reflex micturition, can produce continence in these cases. Unfortunately, simple essential enuresis which can be detected by the "urinary pattern" is found in only a small percentage of cases.

There is a mass of evidence which suggests that "training" methods lead to conditioned responses which initiate micturition either immediately or after some delay. These conditioned responses may over-ride all the other factors and precipitate micturition during sleep. This type has been defined in this thesis as complicated nocturnal enuresis. In such cases fluid restriction will not be of assistance in controlling the condition.

This view of the basic nature of enuresis as an entity or state of physiological origin thus offers an explanation of the failure of fluid restriction in the majority of cases, a failure which hitherto seemed

only explicable on the assumption that the act was of direct psychomotor origin. Likewise the means by which local urogenital lesions influence enuresis can be appreciated as likely to cause an increased potency of the bladder emptying reflex, while disturbances in the integration of the central nervous system by illness or emotion may diminish the potency of the inhibitory function.

From this thesis on the nature of essential enuresis, a method of treatment was planned and developed. The object was to reinforce the inhibitory effect of "somatic discomfort" at the onset of micturition by applying to the skin an electrical stimulus. It was predicted that two separate aims would be achieved by regular use of the regime:

- (1) that any conditioned responses initiating micturition would be weakened, suppressed and finally extinguished so that the complicated type of enuresis would be cured;
- (2) that the inhibitory tone of the detrusor muscle would be steadily increased and that at the same time the potency of the "somatic discomfort" would be restored, until the patient would wake, if necessary, to micturate, thus eliminating the primary type of enuresis also.

A satisfactory clinical instrument was developed. In subsequent application essential enuresis was repetitively cured. An examination of the detailed results of treatment is highly suggestive that, in fact, micturition from conditioned responses is extinguished and that inhibition is developed. The psychological disturbances, which are almost inevitable complications of enuresis, may interfere with the inhibitory mechanisms if the ill effects have been prolonged or are of sufficient intensity.

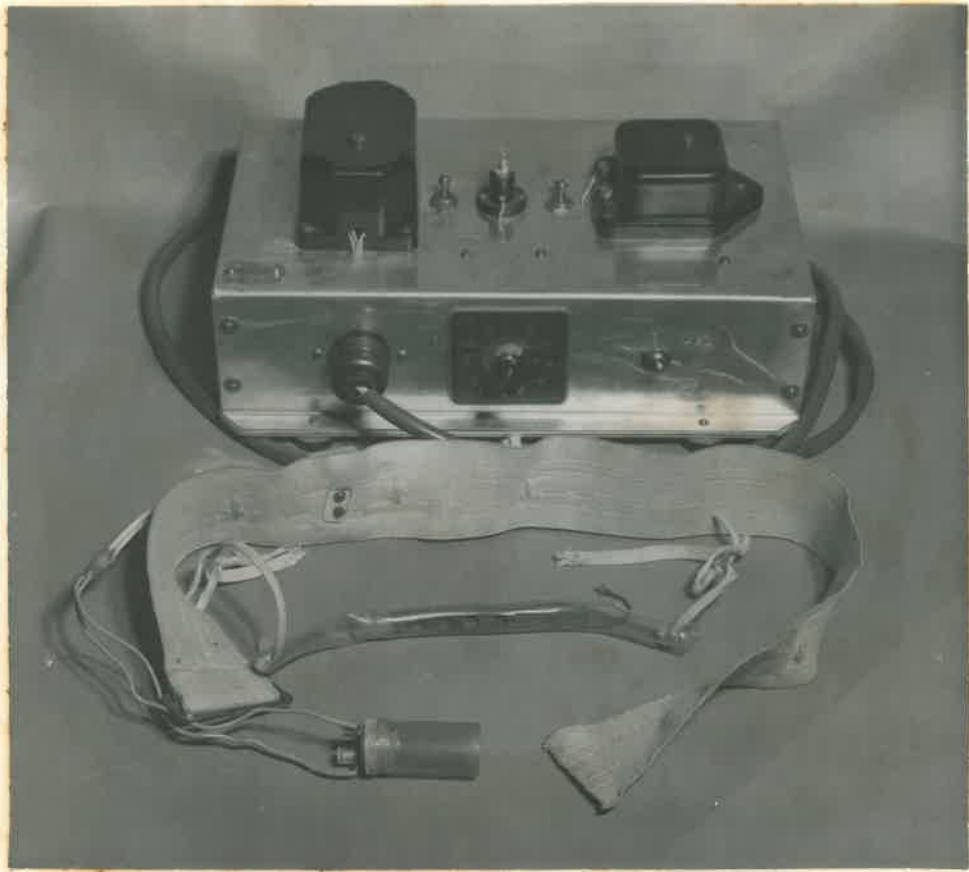
The results of treatment by this method indicate that, when patients are suffering from essential enuresis as defined in this thesis, they can be cured. Sixty-one (61) out of sixty-two (62) consecutive such patients treated were cured. Some relapsed as was predicted, but those who were re-treated were cured again. These results appear to establish the method of treatment as specific; this view is strengthened by the fact that most of the patients had been subjected to prior therapeutic regimes without success.

In conclusion, it is submitted that the results of this research are strong evidence for the validity of this thesis on the aetiology, nature and treatment of essential enuresis.

ACKNOWLEDGEMENTS

Since 1946 when I approached Professor Sir C. Stanton Hicks with my proposal to continue research on emuresis, he has always given me encouragement, as well as facilities in his Department for headquarters and technical assistance. To him I express my gratitude. I wish to acknowledge the great help which Professor M. L. Mitchell of the Department of Biochemistry has given in advice and biochemical facilities in his Department. My thanks are also due to the following: the Board of Honoraries of the Adelaide Children's Hospital for permission to have access to the institution and to have bed space therein; Dr. Eric Sims, while Superintendent of the Adelaide Children's Hospital and subsequently as a consultant, for his interest and help; Dr. H. G. Rischbieth, who succeeded Dr. Sims as Superintendent; Mr. N. S. Stenhouse of the Section of Mathematical Statistics, Commonwealth Scientific Industrial and Research Organisation for the statistical analysis of the incidence in this series; the consultants and practitioners who referred patients to me for this research - I feel that I must specially mention Dr. Ivan Magarey, Dr. F. Ray Hone and Dr. J. M. Bonnin for their interest; and the nursing staff who were prepared to carry out new techniques under novel circumstances; the technical staff of the Physiology Department for assistance in developing the apparatus for clinical use; Mr. W. D. Proudman, medical student, for his assistance; and to Mr. R. T. Young for the preparation of the three illustrations.

PHOTOGRAPH.



APPENDIX I

Photograph of an Instrument and the Attachments used for
Treatment in this Series. See opposite page for
photograph.

Brief Description.

The operative switch is on the front panel of the instrument together with the stimulus adjustment and the four-wire plug. The R. hand switch on the top is the test switch. This particular instrument also has on top a switch which enables a variable thermo-relay to be used if it is desired to limit the time for which the stimulus can act, but it is not needed if the instructions are adhered to rigidly.

The dial pointer is turned to adjust the strength of the inhibitory stimulus.

In this photograph, the belt is connected to the male urine electrode which is screwed into the plastic tube which is used for male patients. The electrode and tube are very light and are fastened to the penis with "Elastoplast" to make a water tight seal. The female electrode is lying transversely and the $\frac{1}{2}$ inch elastic supports are fastened onto the loops of tape which are attached to the belt, so that the female patient wears this in the manner of a sanitary pad and girdle. The female electrode is held firmly, but not uncomfortably, in the vulval cleft.

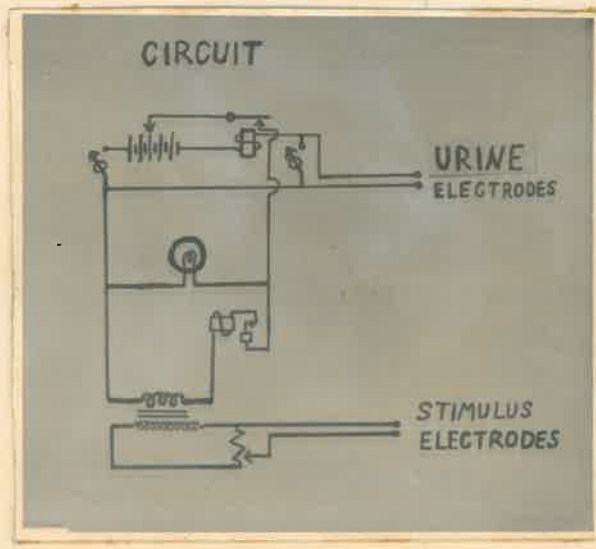
The two stimulating electrodes are seen projecting from a small plastic rectangle on the belt. When the belt is

fastened, these make certain contact with the skin of the loin region.

In practice the unit is placed on a chair at the head of the bed and the cable is tied with tape to one of the head bars in order to prevent the unit being dragged off by a restless patient. The rest of the cable is then passed into the bed under the pillow and the excess coiled alongside the patient's body so that he is not restricted during sleep. The University of Adelaide has applied for a patent for the essential equipment in order to ensure that a satisfactory type will be produced, and has negotiated for the manufacture of suitable clinical instruments.

APPENDIX IA.

ELECTRICAL CIRCUIT OF APPARATUS USED IN THE TREATMENT OF ENURESIS



Eight to Ten volts (8-10) from a dry battery (No. 761) are sufficient for the relay circuit. Four and a half to six volts ($4\frac{1}{2}$ -6) are ample for the secondary circuits. Patients vary in both their skin resistance and their sensitivity to the applied stimulus so that potentiometer needs to be able to vary the stimulus up to about 70 volts in actual use.

APPENDIX II

THE INSTRUCTIONS USED WITH THE EXPERIMENTAL
APPARATUS.

(A) GENERAL:

1. Having started treatment it is not desirable to interrupt it, unless illness intervenes.
2. Younger patients should not be left alone or out of hearing.
3. Important - Always switch off the instrument if, for any reason, the patient has to be left alone.
4. The instrument alone is not the cure of the treatment. Careful attention to all details is essential, and if possible the treatment is done without alarming the patient or making the stimulus hurtful. The instrument is an essential part of this programme designed to cure the patient, but is only a means to that end.
5. Do not drag or twist the wires and cable.
6. Should the light and buzzer act but the patient not show any signs of receiving a stimulus, any of the following may be the cause:
 - (a) The stimulus indicator may be too low.
 - (b) The batteries may be weakening in which case the light also will become dim.
 - (c) The stimulating electrodes may no longer be on the skin (a part of the clothing may have moved between).

- (d) A defect may have occurred.
 - (e) Any short circuit will cause the instrument to operate.
7. Because the patient moves about, a time may come when a wire will be severed and this will lead to 6 (d).
8. Place the instrument at the head of the bed. Bring the cable in under the pillow and allow the excess to coil up alongside the patient. If necessary the cable can be tied with tape to the bar of the bed so that in great restlessness the plug is not pulled out, or the unit dragged to the floor. Limited experience has shown that the belt can be worn by a child in a cot during the day time in cases of diurnal enuresis. The child can stand and move around quite freely, but it is necessary to tie the cable to one of the cot bars.

(B) SPECIFIC:

1. Make sure all switches are turned off.
2. Fasten the belt FIRMLY around the waist with the stimulating electrodes against the BARE skin in the region of the loin. The belt must overlap about 3" to remain firm all night, so that the electrodes remain in contact with skin. This also eliminates the risk of clothes sliding in between or of any creasing of the belt.

APPENDIX II. Contd:

3. Arrange the urine electrodes to the male or female and support in cotton wool in the male or one layer of gauze in the female if desired.
4. Attach the two wire leads onto the terminals of the urine electrodes. It does not matter which wire goes onto either terminal.
5. Make the patient comfortable.
6. Insert the 4-pin plug into the socket of the instrument. This can be done in only one way to avoid wrong contacts.
7. Adjust the dial position to This controls the stimulus and can be varied as seems necessary. Use the least stimulus which will cause onset of micturition. This is later increased to produce wakefulness if necessary.
8. The Switch is turned on.
9. At the onset of micturition, the light and buzzer act as signals to the observer and the stimulus is applied to the patient.
10. Do not allow the signal to last more than approximately 5-10 secs., but turn off the switch. This also stops the stimulus.
11. Remove the contact electrodes and allow the patient to urinate if he desires. Dry the area and re-apply a fresh electrode.
12. Finally, turn on the Switch again. If the instrument operates immediately, the urine

APPENDIX II. Contd:

electrode on the patient is probably not dry, and this must be attended to as carefully as if fresh urination had occurred.

13. Wash and dry the used electrode. These are made so as to be easily changed and washed.

ATTACHMENT OF THE MALE ELECTRODE:

A one inch strip of elastoplast is first placed loosely around the penis. This allows the electrode carrying sheath to be attached and detached without hurting the tender skin. A second piece of elastoplast about $1\frac{1}{2}$ " wide is used to attach the sheath to the penis and make a water-tight seal. The glans or prepuce must not make contact with the electrode. Some cotton wool is laid about the terminals and the whole can be held in an athletic-support if desired. The cotton wool prevents contact with skin and avoids electrolysis. It also will be able to absorb any small quantities of urine passed, and in most cases prevents soiling of pyjamas.

THE ATTACHMENTS FOR FEMALES:

These are worn in similar fashion to a sanitary pad, being held in place by two elastic tapes which are tied to the waist belt via attached loops. If desired, they can be wrapped in one layer of gauze. They are so made that automatically the electrode surface is held uppermost, and the only care needed is to see that the electrode lies in the vulval cleft in such a position that urine must pass into the electrodes.

THE STIMULUS:

By touching the two terminals together after switching on, the instrument can be tested and the stimulus adjusted. Do not use the patient (especially if a child) to test the strength of the stimulus, which can be gauged on the forearm of the observer as of perceptible but not unpleasant intensity.

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