CHAPTER 24

Treatment of Enuresis with an Enuresis Alarm

SYLVIA DISCHE

Use of an enuresis alarm is a most successful way of treating bedwetting. While the procedure is not a difficult one, it calls for the whole-hearted co-operation of child and parents, and for this the doctor must feel himself responsible. Although in some cases cure is rapid, the alarm must be used for at least three to four weeks, and often for several months. Adequate explanation of the form of treatment will usually result within the first few weeks in an evident response, which usually gives sufficient encouragement to enable the family to continue the programme to its completion.

The basis of the working of all makes of apparatus is the sounding of an alarm —a buzz, a bell or a continuous or interrupted high note—when wetting completes an electrical circuit between two electrodes, in the form of mats, placed under the child in his bed.

Preparation for Using an Alarm

Two to three weeks before the apparatus is issued, the parent is given a brief description of the method. It is emphasized that the keynote of success is the child's waking rapidly as soon as he begins to pass urine. This moment is signalled by the sounding of the alarm.

To make sure that the child wakens quickly and follows the correct routine, one of the parents is asked to sleep for a time in the same room as the child. This is also desirable both to give him companionship when suddenly woken and to help him remake the bed. Parent and doctor discuss how sleeping arrangements can be altered temporarily, and which parent will be helping the child. It is wise to insist that the mother talks the matter over with her husband to make sure he is agreeable. In families where overcrowding or the age and sex distribution of the children make it impossible to alter the sleeping arrangements, one can issue a buzzer with an extension which will sound simultaneously in the parents' room. Although it is possible to use an alarm where the bedwetting child is sharing a bed (provided the companion is not also enuretic) it calls for such a high degree of collaboration that it is far better to help the parents to buy an extra bed. There is rarely any difficulty in obtaining the required parental co-operation. A clinic which is devoted mainly to helping enuretic children is itself a source of optimism. New attenders are encouraged by the reports of others whose children have improved.

Demonstration of the Procedure

The doctor explains to the child that he is going to be lent a special kind of clock that will help him to become dry more quickly. This clock will be his friend, and will call him with a loud noise the minute he starts to wet the bed. He will then have to

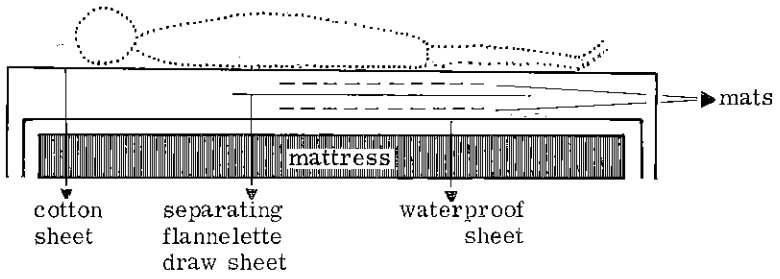

Fig. 1. Arrangement of mats and bed sheets. Lateral view.

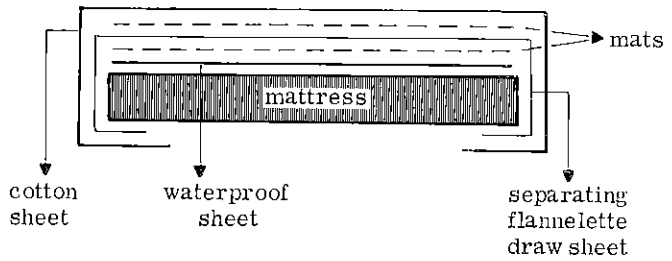

Fig. 2. Arrangement of mats and bed sheets. Cross-section of bed.

get out of bed quickly, switch off the friendly clock, and use the lavatory or potty. As a gentle introduction, the doctor sounds the alarm for the child, who is asked to see how quickly he can get up from his chair and switch it off. Then, using the clinic couch as bed, and with frequent reference to the explanatory diagram provided by the manufacturers, the mother and child are shown how to make up the bed for use with the alarm.

The child should be asked to put each layer in position himself. Where the alarm system uses two mats, these are placed across that part of the bed on which the child's buttocks will lie. The bottom mat lies directly on the water-proof sheet covering the mattress. A flannelette sheet of draw-sheet width separates the two mats; this sheet must be in good condition and free from holes, and should extend at least nine inches beyond the mats. The child lies on a full-length thin cotton sheet which separates him from the upper mat (Figs. 1 and 2). Each mat is attached to the alarm unit by a lead with press stud or crocodile clip connections. Where two wire-mesh mats are used, the crocodile clips must pass beyond the peripheral binding and make contact with the mesh, and the clips on the two mats must not lie on top of each other. With the Astric model there is only one mat, and this lies directly beneath the full-length cotton sheet.

The child must not wear any clothing below the waist, and he must not have a hot water bottle in the bed. He can have his usual covers on top of him. The best place for the unit is on the floor under the head end of the bed, but if expressly desired it can be put on a small table or chair *beyond arm's reach from the bed.* It should be

stressed to the family that both the flannelette draw-sheet and the full-length cotton sheet must be firmly tucked in under the mattress to prevent slipping of the mats.

The next step is to rehearse what will happen at night. The child pretends it is bed-time, and visits an imaginary lavatory. He then switches on the alarm unit. If the model is the Eastleigh transistorised alarm unit to the Ministry of Health specification*, he presses the test button to make sure that the mats have been correctly assembled; after hearing the reassuring signal he must turn the switch off, *and then switch on again* before getting into bed. He lies down and pretends to be asleep. The doctor makes the alarm sound. The child gets out of bed, switches off, and visits the imaginary lavatory. (The parent should be advised that when the treatment is started the child must actually be accompanied to the lavatory, to ensure that he really does get there and does empty his bladder.) The doctor explains that it is the middle of the night and the child must go back to sleep, but first one of his parents will help to put dry sheets on the bed. (The mats and waterproof sheet can be dabbed dry with the remaining dry areas of the used sheets; the Astric manufacturers recommend that their pad be rinsed regularly.) The parent and the child practice making up the bed together, and the child switches on the alarm. The routine is repeated until he is adept.

The doctor explains that often at the beginning of this treatment some children wet the bed more than once a night, but that the routine must be faithfully followed *each time;* he promises that the number of times will gradually decrease until bedwetting does not occur at all. Emphasis is placed on the fact that the basis of success lies in the child waking up at the instant he starts to wet, *i.e.* as soon as the alarm sounds. The parent must not wait to see how long the child will take to waken on his own to the alarm call—he may well do so quickly, but the parent should always start to gently wake him as soon as possible. The alarm must be left sounding until the child is out of bed, and can switch it off *himself.* During the rehearsal, the child should be encouraged to see how quickly he can get off the couch when 'called' by the alarm. The child and his parents should be told that after the first few nights the wet patch must never be bigger than the size of a saucer. The child must have plenty to drink before going to bed (*vide infra*), in order that when treatment is concluded everyone will be confident that he has learned to be dry while coping with large volumes of fluid, and will not feel any need to worry about how much it is safe for him to drink.

The child can henceforth go to bed knowing that, even if he does wet, he has a 'friend' to wake him quickly, and the bed will not be very wet. In any event, he will be getting out of a dry bed every morning. He is assured that as he continues to get out of bed quickly when 'called', he will start to wake up *before* he wets, and will 'beat the buzzer'. Emphasis should be placed on two important rules. (1) The child must always switch on the buzzer just before he gets into bed. (2) Only he is allowed to touch the switch. One of his parents may *remind* him to switch the alarm on or off, but that is all.

New mats are issued to each patient, and parents are told that they are not expected to return them at the end of treatment.

*Henceforth referred to in the text as Eastleigh MOH 1.

The demonstration is supplemented by written instructions, and the parent and child are also given the manufacturer's explanatory leaflet.

Explanation of How Alarm Works

When the rehearsals have been completed, one should explain what makes the alarm sound. It is better to keep demonstration and explanation quite separate. With younger children, the demonstration is done before the explanation. With children of thirteen years or more, it may be better to give the explanation before doing the demonstration.

With two-mat systems and the non-transistorised Eastleigh model, the child switches on the apparatus, and the doctor shows that the slightest contact between the mats causes the alarm to sound. The dry flannelette sheet keeps the mats separate, but the instant this sheet becomes wet it has the effect of making a contact between the two mats with the resultant buzz. (The inexperienced demonstrator must be warned not to demonstrate this point with tap water: most tap waters will not oblige until a little salt has been added.) It now becomes clear why one has emphasised that there must not be holes in the separating sheet—the mats would touch each other and cause the alarm to sound without the child being wet. Similarly, should the alarm sound when the bed is dry, inspection of the mats will show that the separating sheet has shifted and the mats are in contact—hence the need for firmly tucking in the sheets.

With the Eastleigh MOH 1 model, the test button or the child wetting will not produce a buzz if the two mats are in contact.

The doctor has also to explain that since the alarm sounds only when the separating sheet becomes wet, and because the success of the treatment depends on rapid wakening at the moment of wetting, the urine must get through to this sheet very quickly; clothing below the waist or a heavy sheet directly underneath the sleeper would soak up urine and delay sounding of the buzzer. The reason for using a flannelette sheet to separate the mats is that heavy perspiration could make the alarm sound if a thin cotton sheet were used.

In the case of the Astric model the principles are the same; the alarm sounds when urine bridges the foil strips at any point, and the alarm sound can be demonstrated by bridging the foils with a metal object, *e.g.* a key. One should warn the parent that an added reason for not allowing the child to go on sleeping in the wet bed is that his skin could become very sore.

The child must continue to use the alarm every night until he is told it is no longer necessary. Parents must be cautioned not to 'lift' before they retire, in the hopes of having an undisturbed night, because this would interfere with the training. The child is asked to record on a chart both the number of times the alarm calls him each night, and the nights when he has been completely dry. It is as well to tell the youngster that he will find himself waking and wanting to empty his bladder.

Before the parent and patient depart, arrangements are made for the clinic nurse or social worker to visit the home within the first week to make sure that all is going well. However, should there be any queries before this time, it should be made possible to telephone or call at the clinic for answers to these and for advice.

As a rule, it takes half-an-hour to demonstrate the alarm in the above way, but

it is time well spent. Possibly the greatest advantage is in developing a happy attitude in the child to this particular form of help. Explanation of the way the buzzer works is helpful to the parents, and makes it easier for them to deal with false alarms or to ask for help. The insistence on parental co-operation contributes greatly to a successful outcome, because both the parents and the child benefit enormously from the change in atmosphere. The parents, instead of being resigned, anxious or resentful, become helpful participants in the treatment scheme. Where one is planning to issue a number of alarms, it is feasible to demonstrate the procedure to two or three sets of parents and children at a time. The children enjoy this very much.

Before they leave and after the explanation and rehearsal, the parent and child are told that children vary greatly in the speed with which they start to improve, and it is not possible to predict how long they will need to use the alarm. They are also shown how to test the battery, by noting the intensity of the sound when the two clips touch or when the test button is pressed.

Supervision

The parent and child should visit the clinic every three weeks. Where distance is a factor, regular postal reports can be sent (Fraser 1971), in which daily entries record whether the child was wet or dry, at what time the buzzer sounded, the size of the wet patch, and whether there was spontaneous waking. The parent and child usually decide for themselves when the parent can return to his or her own room, but to ensure that the child gets out of bed a parent must continue to get up whenever the alarm sounds. Even very young children can appreciate the importance of never failing to get out of bed, and will often go into the parents' room to announce that the alarm has sounded and they are on their way to the lavatory.

Long before the child is completely dry, the number of times he wets and the size of the wet patch decrease. Treatment is continued until there is an unbroken run of 21 dry nights. Alarm and mats are put aside, but not immediately returned. The mother is advised that an occasional wet bed need not cause concern, but that should the child have two wet beds (not necessarily consecutive ones) in any seven days before they are next seen, they should use the alarm again until 21 dry nights are once more achieved. When three further dry weeks have been maintained without using the alarm, the apparatus can be returned. The parent and child are seen at lengthening intervals until dryness has been maintained for six months. Then they can be discharged. The criterion of dryness should be that used by White (1968), *i.e.* there should not be more than one wet bed a month. On discharge, the advice about ignoring occasional wet beds is repeated, but parents are asked to contact the clinic immediately should there be three wet beds in a week. After discharge, further follow-up is done by letters, and home visists by educational welfare officers.

Most children, as they begin to respond to treatment, wake up spontaneously during the night to empty their bladders. Later, however, the majority do not have to waken at all, but sleep through the night and wake up dry in the morning. Other workers differ on the length of time the child should be dry before discontinuing the alarm. Forsythe and Redmond (1970) found that relapse was less likely with a minimum of four weeks dryness, while Young and co-workers (Young and Turner 1965, Turner

et al. 1970, Young and Morgan 1972) discontinue treatment after fourteen nights of dryness.

Important Points During Treatment

The mother should be told that the child may have an impressive run of dry beds and then have more wet beds. They should not feel discouraged because of this; they should carry on using the alarm until instructed to discontinue it, and must not be tempted to 'see if he can do without it'.

The possibility of the battery wearing down must constantly be borne in mind, and when the child is wetting infrequently the battery must be tested from time to time. Young and Morgan (1972) actually check the voltage of the battery at each visit to the clinic.

Mesh-type mats must be inspected to ensure that there are no broken pieces of wire that might penetrate the separating sheet. Where aluminium foil is used, it must be inspected for small cracks, as these will interrupt the circuit. Regular enquiries must be made about the condition of the mats, and new ones issued where necessary. The time that the mats can be expected to last varies with individual users, and is probably affected by the composition of the urine and the restlessness of the sleeper. A pair of mats may serve one child for four months, whereas another may require two sets of mats over a similar period. The foil mats have the shortest life. A sagging mattress is said to interfere with satisfactory operation of the alarm device (Davidson and Douglass 1950).

Rectangular mats are normally placed lengthwise *across* the bed, but if the child is liable to work himself up or down the bed it is useful to place them lengthwise *along* the bed.

If a child is seriously distressed by having to leave off clothing below the waist, he may wear mesh-type nylon underpants or thin nylon pyjama trousers.

Parents must be warned not to allow the sheets to dry before re-use without washing them, for false alarms may result (Eastwood, personal communication). When the wet patch is small, if the sheets are large enough, it may be practicable after the first wetting to 'draw' them, so that the wet patch is not in contact with the mats.

Results

Success Rate

Young (1969) has prepared a table summarising the results of 19 published reports of conditioning treatment; the number of cases in the different series varies from 11 to 445. The success rate ranges from 63 to 100 per cent, and these figures include defaulters. In Young's own series, if defaulters were excluded, the percentage cured was 92. Forsythe and Redmond (1970) recorded a success rate of 66 per cent in a series of 200 cases, and this included defaulters. In a series of 84 children, Dische (1971) had a cure rate of 83 per cent including, and 92 per cent excluding, defaulters.

Children with secondary enuresis respond as well as those with the primary type. Treatment is successful at all ages, although White (1968), in her impressive study of 1000 children, felt that older children did less well. The success of the treatment is not related to the initial severity of the enuresis.

Time Taken for Cure

One can expect a quarter of all children with nocturnal enuresis treated with the buzzer to become dry in two to six weeks, a half to become dry in between one and three months, and nearly 90 per cent to be dry within four to six months (Dische 1971, Fraser 1972). White (1968) recorded in 359 children an average length of buzzer treatment of $2\frac{1}{2}$ months. Forsythe and Redmond (1970) considered that if the child was not cured after 16 weeks his chance of cure was small, but in my experience some children are cured after as long as four or more months of treatment. In these cases, although the child may not have reached the criterion for cure, he may only be wetting two or three times a month. Fraser (1972) makes the point that no arbitrary time limit should be set for return of the buzzer. If, after three to four months, faithful usage has not produced obvious progress, the child should be re-assessed for unrecognised emotional or organic disorder.

Many mothers voluntarily remark on the over-all improvement in the child who has become dry. In my experience undesirable side effects and symptom substitution have not occurred.

Selection of Cases for Treatment with an Alarm

One cannot generalise on the lower age limit for treatment. On the whole, children of seven years and older can successfully use a buzzer, and so can a number of five-year-olds who are able to understand the purpose of the alarm call. Mentally retarded children can be successfully treated, so can very timid ones, especially if the explanation is given in a friendly way using vocabulary suited to the child's age; it may also help to use the child's bed-time cuddly toys to share the demonstration. In general, the criteria for suitability for treatment are: (1) that organic disease has been excluded, (2) that there has been no satisfactory response to simple supportive measures, (3) that the child is wetting at least three times a week, (4) that the child understands the purpose of the routine and can readily carry it out, and (5) that the parents are prepared to co-operate actively in treatment, to persist with it, and to attend for regular supervision.

Where conditions seem obviously unfavourable to successful usage, it is far better not to give a buzzer 'in the hope that it may do the trick', but to concentrate on helping the family with its other problems and on working towards making usage of the buzzer possible. Many of the children who attend enuresis clinics have already been unsuccessfully treated by a variety of methods, and yet another failure is likely to worsen such a child's already poor self-image and intensify a feeling of hopelessness in the family.

The clinic social worker can help by revealing sources of financial aid, obtaining an extra bed, or arranging laundry assistance. Housing problems may be aided by reference to the housing officer of the local authority or by an introduction to a local housing trust. The clinic social worker may be able to organise a holiday for some of the family. During this period of purely supportive help pending usage of the buzzer, regular contact with the child and family is maintained both by the social worker's home visits and by regular clinic attendance. This contact is important. Mother and

child are thereby assured of the doctor's continuing interest, even though buzzer treatment is not yet appropriate.

Relapse After 'Cure'

This remains the disappointing feature of an otherwise very successful treatment method. It can be expected that, after becoming dry, about 30 per cent of children will not merely have occasional wet beds, but will relapse sufficiently to need re-treatment (Dische 1971, Young and Morgan 1972). Most relapses occur within six months of the initial cure, but a small number may occur up to two years afterwards. For the purpose of assessing measures designed to decrease the relapse rate, a follow-up period of two years is essential.

Freyman (1963) felt that younger children were more likely to relapse than older ones. This has not been confirmed, however, and most workers feel that there is no relationship between incidence of relapse and age, sex, type of enuresis, or frequency of wet beds prior to treatment. In my experience, relapse is not significantly related to continuing background difficulties, and is only rarely associated with acute stress events such as a move to a new house, illness or family disruption.

Although, in the absence of organic disease, day-time wetting and day-time soiling usually improve concurrently with improvement in the bed-wetting, the co-existence of either of these with bedwetting is often a pointer to a greater likelihood of relapse. A definite factor predisposing to relapse is the use with the alarm of the cortical stimulants dextro-amphetamine and methyl-amphetamine. Turner and Young (1966) showed that, although giving the drugs shortened the time required to become dry, it markedly increased the relapse rate.

Young and Morgan (1973) investigated 40 factors of possible relevance, and concluded that relapse after buzzer treatment 'is an occurrence resulting from inefficiences in the treatment itself, and is independent of patient and background variables.

Retreatment is successful, and may take a shorter time than the original course. A few children have two or more relapses.

Young and his co-workers have drawn attention to two modifications of the treatment programme which may be of value in reducing the relapse rate. Turner *et al.* (1970) used an intermittent instead of a continuous schedule, and found some evidence that this procedure may lower the relapse rate. In a later study, Young and Morgan (1972) evaluated the effect of 'overlearning'. When, after a standard regime, their patients had achieved fourteen nights of dryness, they were instructed to drink two pints of fluid in the hour before going to bed. Only 7 out of 55 patients on the 'overlearning' regime relapsed, compared with 16 out of 46 who did not have a period of extra fluid ingestion after becoming dry. Follow-up ranged from three months to a period in excess of two years.

Difficulties Encountered During Treatment

The Child Who Does Not Wake to the Alarm

This is often cited as the great difficulty in treatment, but in fact it need not constitute a problem. Some children do, in the early stages of treatment, have to be

woken, but if the parent conscientiously wakens the child, leaving the alarm sounding until the child is out of bed and can switch it off himself, the difficulty usually resolves itself after a few nights. If the trouble continues, it invariably responds to introducing an element of competition into the nightly routine. A 'game' chart is drawn up, and the child and mother record which of them gets to the buzzer first (though even if mother wins the race she does not touch the switch). The child soon acquires the higher score. Increasing the intensity of the sound of the alarm rarely makes any difference. The better answer is the helping parent. Some suggest the use of a long-acting dexamphetamine, to make the child sleep more lightly, and also, probably, to improve conditionability; but these theoretical advantages must be weighed against the risk of a higher relapse rate and the undesirability of using amphetamine preparations at all. Methylphenidate hydrochloride ('Ritalin') has been tried as an alternative to amphetamines.

Parents Unable to Persevere With Treatment

Fraser (1971) makes the point that 'when parents co-operate poorly it does not always mean that they are indifferent to the child's enuresis or unwilling to make the effort to help'. They may be well-intentioned but overburdened. Both parents may be going out to work. They may be of low intelligence, or themselves emotionally disturbed.

Interruption of sleep more than once a night in the first week or two may be trying, particularly if the helping parent has anyway to get up very early. Some parents get disheartened while they are having to waken the child. Both these problems can be anticipated, and early and regular supervision enables the family to surmount them.

False Alarms

One of the most irritating difficulties is the sounding of the alarm when the child is not wet. In two-mat systems, other than the transistorised Eastleigh MOH 1, this will occur if the two clips or the two mats come into direct contact. As previously mentioned, the direct contact will occur if there are holes in the separating sheet, if the sheet becomes displaced, or if the sheet is penetrated by frayed wires. All these situations can be dealt with by the parents themselves, if they have been briefed at the initial demonstration and on early supervisory visits. Use of a separating sheet which has been allowed to dry without being washed will also cause false alarms—heavy perspiration on the dried urinary deposit will have the same effect as wetting. An inadequately laundered separating sheet is the only cause of false alarms in the transistorised Eastleigh model MOH 1. With the single Astric pad, false alarms may occur because inadequate rinsing of the pad has resulted in residual urine bridging the foil strips.

Failure of the Alarm to Sound When the Child Wets

A crocodile clip on the lead may become accidentally detached. Mention has previously been made of the necessity for regularly testing the battery. Where aluminium foil is used, either for the whole mat or as a strip stitched on to the mat, cracks will interrupt the circuit.

The transistorised Eastleigh MOH 1 model operates on a principle that prevents a false alarm on a dry bed due to the mats accidentally touching. If there is accidental contact, pressing the test button will not produce a buzz; nor will the alarm sound if the child wets and the mats are touching.

Buzzer Ulcers

These are a potentially serious problem, although fortunately not very common. The subject is dealt with fully in Appendix I of this paper by Dr. S. R. Meadow.

Other Difficulties

Other difficulties include the child being too frightened to sleep with the buzzer, or the child sabotaging training by disconnecting leads or obstinately wearing pants. In the first instance, the presence of a parent sleeping near the child should obviate the difficulty, but the fright may be indicative of inadequate explanation and preparation. The sabotaging child may be more emotionally disturbed than was originally suspected (Fraser 1971).

APPENDIX I

Buzzer Ulcers

S. R. MEADOW

In 1958 Gillison and Skinner, general practitioners in Derbyshire, reported that over 20 per cent of the children to whom they issued enuresis buzzer alarms developed a rash. The rash was on the buttocks and thighs, and consisted of red papules, some of which became ulcerated. Gillison and Skinner were using a single pad with spirally arranged electrodes connected to a 4·5 volt battery. The incidence of the rash was decreased by increasing the thickness of material lying between the pad and the child, and by dusting the child's buttocks with boric acid powder.

In 1963 I saw two children with this ulcerated rash, who were using twin perforated foil sheet electrodes. The distribution of the ulcers followed the spacing of the perforations. In both cases it was the mother who noticed the ulcers, and not the child; the ulcers neither itched nor hurt.

Borrie and Fenton (1966), encountering two examples of these ulcers, reported that they occurred when the children failed to awake on wetting, as a result, for example, of a faulty alarm or a run-down battery which was not powerful enough to sound the alarm. They tried to reproduce the ulcers experimentally using the same alarm equipment (which has a single pad with coiled electrodes and a 4.5 volt battery). As the main electrolyte in urine is sodium chloride, they applied filter paper soaked in sodium chloride against their skin, and pressed the pad electrode against it. Current from a 1.5 volt battery applied for 80 minutes produced neither pain nor injury. Current from a 3 volt battery produced tingling after 3 to 7 minutes, but no sign of injury at 25 minutes. The experiment was discontinued. But a day later a colleague

Fig. 3. Buzzer Ulcers.

noticed that the experimenter had a punched out ulcer on the skin where the pad had been. It was painless.

On the basis of this experience, Borrie and Fenton suggested that ulcers occurred in those areas of skin in contact with both anode and cathode and the moist electrolyte-soaked sheet or blanket. When the sheet became wet, current was conducted through the sheet and through the skin across the electrodes. Electrolysis of NaCl would result in some NaOH production, which could cause a chemical burn. It was found that the ulcers usually occurred at the cathode, suggesting that it was the basic ions which were harmful. The ulcers would be more likely

(1) when the skin was soaked for a long time, so losing the natural electrical resistance of the stratum corneum; and
(2) when firm pressure of the skin on the sheet and pad ensured good contact.

Since then there have been several reports of buzzer ulcers. They start as raised red areas, which, within twenty-four to forty-eight hours, either subside or progress to become circular punched-out ulcers. They are usually painless. Healing occurs within four to eight weeks, and is usually complete, though permanent scarring (Forrester 1966) or keloid formation (Borrie and Fenton 1966) may result.

Buzzer ulcers have been reported with apparatus containing single pad coiled electrodes, and also with twin metal foil electrode sheets. They have been reported with batteries of 4 to 6 volts, and reproduced experimentally with a 3 volt battery. They have usually been seen in situations where either:

(1) the alarm has not awoken the child;
(2) the alarm has been deliberately switched off by the child; or
(3) the alarm has failed to be activated by a run-down battery.

In 1968 the Ministry of Health concluded its trials of enuresis alarms, and produced a 'Performance Specification'. This included a list of basic safety requirements, as well as several optional facilities. Few of the alarms currently available utilise all the Ministry's recommendations, but most incorporate the more important.

Although the use of enuresis alarms has increased, buzzer ulcers have become rare. I have not found any reports of ulcers occurring with twin wire mesh electrodes, nor with transistorised alarms, which produce a maximum of 0·7 volts. Nor have the makers of one such widely-used piece of apparatus been notified of the occurrence (Eastwood 1971—personal communication).

The most important requirements for a safe enuresis alarm, unlikely to cause buzzer ulcers, are:

(1) an alarm which can not be switched off without switching off the complete electrical system;
(2) a system in which it is impossible for any current (*e.g.* from a weak battery) to pass across the electrodes, unless the alarm is sounding;
(3) noisy alarms;
(4) twin electrode sheets, the upper having perforations that are so small that skin cannot come into contact with both electrodes;
(5) care in ensuring that the twin electrode sheets lie accurately over each other, so that there is no margin on which the child may lie in contact with both sheets;
(6) the use of low-voltage transistorised alarms.

Not all these six features are necessarily required for each alarm. But provided that the alarm combines enough of these features in its design to be safe, is well maintained, and its use is closely supervised, buzzer ulcers should not occur.

APPENDIX II

Enuresis Alarms: a Performance Specification by the Ministry of Health

In the treatment of enuretics with Enuresis Alarms, cases of ulceration (also known as 'buttock' or 'buzzer' ulcers) have been reported. The ulcers result from electrolysis of urine, or even perspiration, in direct contact with the skin of the patient, due to the current flowing between the detection electrodes of the alarm.

This danger to the patient can be minimised by a sensitive detector which limits the current in the detection mats to a low level, and by using an arrangement of mats which makes electrolysis in contact with the skin highly unlikely even under unfavourable conditions, *e.g.* displacement of the bedsheet covering the mats. Recent trials sponsored by the Ministry, and the results of other investigations, enable the desired requirements to be specified. These are given below. The specification has

been framed to provide a safe and reliable alarm which can be produced commercially at a reasonable price.

Hospitals are being informed about this performance specification.

Basic Safety Requirements

(1) The maximum current that the detector mats can draw from the alarm must not exceed 100 microamperes d.c.

(2) Potentials exceeding 15 volts must not be used or generated in the circuit. This requirement includes transient voltages which may be produced by inductive components.

(3) Exposed metal parts of the alarm must be electrically isolated from the detection mats.

(4) The detection electrode assembly must consist of two conducting mats or an equivalent arrangement which prevents the patient from coming into simultaneous contact with both electrodes.

Note: the arrangement of two conducting mats requires the top mat at least to be perforated with small closely spaced holes (*e.g.* $\frac{1}{4}$ inch diameter at $\frac{3}{4}$ inch centres), and the use of a porous insulating separating layer (*e.g.* a piece of cloth) between the two conducting mats.

(5) The wires from the alarm must be attached permanently to the mats or be connected to them in such a way that unintentional disconnection is not likely.

Note: crocodile clips are not considered suitable connectors.

(6) The apparatus must be battery powered.

(7) Plug connectors which fit standard mains sockets must not be used.

(8) Connections to the alarm for different purposes, *e.g.* extension alarms and mats, must not be interchangeable.

Operating Requirements

(1) The resistance between the electrodes which causes the alarm to operate must lie in the range 250 to 10 000 ohms, at an ambient temperature of 0 to 25°C, from full battery voltage to 2/3 nominal battery voltage.

(2) Once triggered, the alarm must continue to operate until reset by a switch.

(3) A summary of the instructions for use should be printed on the alarm.

Recommended Facility

(1) A low wattage lamp which lights when the audible alarm sounds. This provides reassurance to the patient when woken, and enables the controls to be seen.

Possible Facilities

(1) A socket into which an extension alarm may be plugged.

(2) A switch to cut out the audible alarm and leave only the lamp to function as a visual alarm.

February 1968

Ministry of Health,
Scientific and Technical Services Branch,
14 Russell Square, London W.C.1

R/E1004/03

APPENDIX III

Types of Alarm in Use

Transistorised alarms have been developed to minimise the risk of ulcers. *Non-transistorised models* are, however, still in use, and can be employed safely with certain provisos. *The type of mat* used plays a large part in determining the safety of the apparatus in relation to ulceration: it is important that the patient's skin should not be able to come into contact with both electrodes simultaneously, even through a wet sheet. This accident could occur where the two electrodes are stitched on to one mat, or where the perforations in the upper mat are sufficiently large to allow the skin to make contact with both electrodes; it could also happen if the two mats are not correctly aligned on top of each other. These risks are minimised if the alarm unit is transistorised. The mats that most ideally fulfil safety requirements are those of the wire mesh type in which the perforations are so small that the skin cannot make contact with both mats. In addition, these mats are very efficient because of the rapid passage of urine to the separating sheet and sounding of the alarm. Aluminium foil sheets, the upper one perforated, the lower one plain, are widely used because they are cheap. However, they have a short life and the foil cracks.

Meadow (see Appendix I of this Chapter), commenting on safety factors, suggests that each alarm need not incorporate every safety device, 'but, provided that the alarm design combines enough of these features to be safe, is well maintained and its use closely supervised, buzzer ulcers should not occur'.

Details of the most widely used commercially available alarms made in the U.K. are listed below. In addition, some hospitals and clinics have invented their own rather cheaper models.

I. The Astric Dry-bed (Figs. 4 and 5)

Obtainable from Astric Products Ltd., 261 Queen's Park Road, Brighton, Sussex. This device is the only available alarm which utilises a single detector pad.

Case. An injection moulded plastic box; choice of sealed or unsealed model. Sealed model can be supplied with manganese alkaline batteries, which should give two years' shelf life and one year's usage. Replaceable HP7 batteries used in unsealed model. Pad connected by length of flex to jack plug; pushing this into socket closes switch and alarm is then ready for use. Alarm is switched off by pulling out plug.

Pads. The single pad consists of two strips of pure, soft, tempered aluminium, stitched in spiral fashion to plastic sheet; the pad is eyeleted and can be secured to mattress with tapes; it should be rinsed regularly to prevent build up of urine which can cause false alarms; the pad is guaranteed to last for eight weeks.

Sound of alarm. Loud and steady humming tone; if battery is running down the note will rise.

The bed is easy to make up with only one pad.

Cost. Complete alarm (unit and pad): (i) £9.50 or three monthly instalments of £.350 (repurchased after use for £2); (ii) £7.75 to hospitals and clinics. *Pad:* (i) £1.20; (ii) £0.90 to hospitals and clinics.

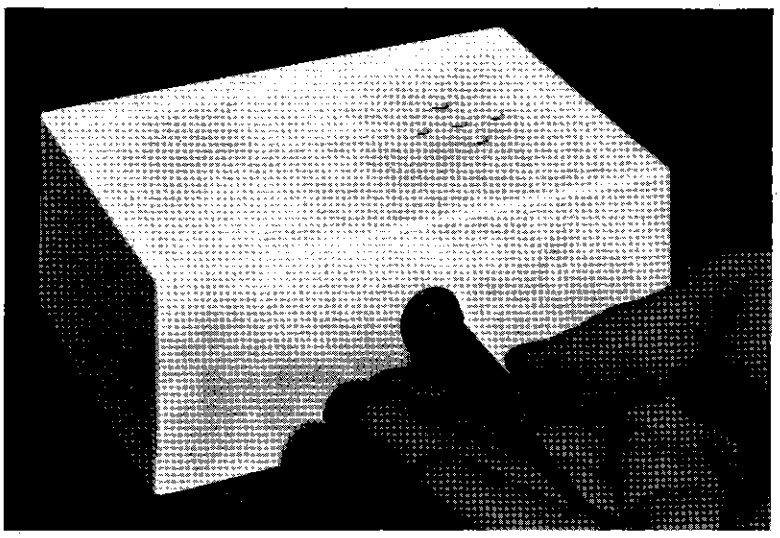

Fig. 4. Astric alarm unit.

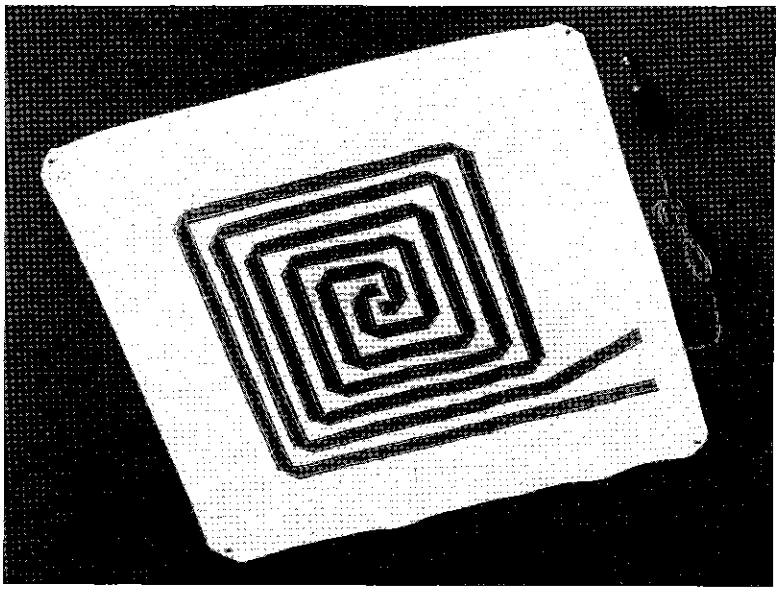

Fig. 5. Astric mat.

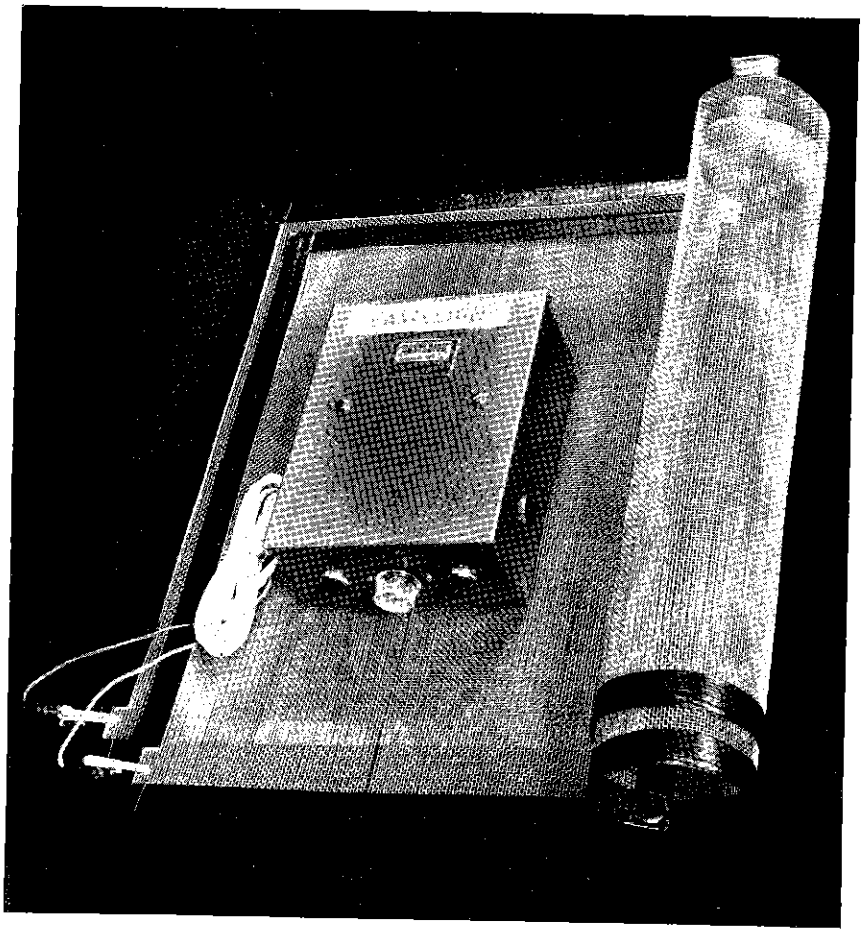

Fig. 6. Standard Eastleigh Alarm unit and mats. (In the transistorised alarm unit made to the Ministry of Health specification, the unit has a red test button, and the leads attach to the mats by press button studs.)

II. Eastleigh Alarm Devices

Obtainable from N. H. Eastwood and Son Ltd., 48 Eversley Park Road, Winchmore Hill, London, N.2. At the time of writing the non-transistorised standard Eastleigh (*see below*) is still widely used, but the manufacturers are about to transistorise this model.

Standard Eastleigh for Hospital and Clinic Use (Fig. 6)

Case. Heavy duty steel; 'on/off' switch; also 'low/high' switch to control intensity of sound; small light which comes on when buzzer sounds; jack socket at side of case for plugging in either booster buzzer or extension to sound simultaneously in another room. Ever Ready 996 battery.

Sound of alarm: loud buzzing noise.

'Dri-Nite' Transistorised Alarm

For domestic (*i.e.* not clinic or hospital) use only. Compact plastic case.

Alarm sound: single tone bell.

Eastleigh Transistorised Alarm to Ministry of Health Specification (MOH 1)

Case. As for standard Eastleigh model above. In addition, it has a red test button which if pressed with the apparatus switched on will make the alarm sound (a) when the connecting studs are parted (indicating that alarm is working and batteries are in order), and (b) when the leads have been attached to the mats, which are correctly separated by draw sheet. Uses Ever Ready 996 battery.

Alarm sound. Loud buzzing noise.

Mats. The mats used with all models are specially woven from anti-corrosive wire, and have the appearance of fine mesh. Those for use with the (at present) non-transistorised standard Eastleigh have areas at the corners where the binding tape is narrowed for crocodile clips to clip on to the wire mesh.

Mats for use with transistorised MOH 1 come in pairs made of dissimilar metals—one looks gold, the other silver; each mat is attached by means of press studs to the appropriate lead from the unit.

These mats should last two to three months, and being finely meshed have the advantages referred to previously; the MOH 1 model eliminates false alarm buzzing on a dry bed due to mats or clips touching; it is extremely useful to have the availability of an extension which will sound simultaneously in the parents' room; the instruction leaflets issued with these alarm devices are very clear and detailed.

It is possible for the crocodile clips on the present Standard Eastleigh to become accidentally detached; there is occasional staining of sheets by the mats; the mats should be inspected regularly for frayed wires.

Cost. Complete alarm (unit + 2 mats): (i) Standard Eastleigh £8.60; (ii) Dri-nite alarm £6.40; (iii) transistorised MOH 1 £9.20. Bed-mats per pair: (i) for use with Standard model £1.60; (ii) for use with MOH 1 £1.70. Booster buzzer £1.20. Discounts up to 25 per cent on apparatus supplied to hospitals and clinics.

Hiring: £5 for 4 months—includes mats and booster buzzer.

III. Wessex Transistorised Enuresis Alarm Built to MOH Performance Specification

Obtainable from the Wessex Medical Equipment Co., Romsey, Hants.

Case. Metal; 'on/off' switch; light which comes on when alarm sounds; metal gauze over speaker; instructions for use clearly printed on lid (Fig. 7).

Alarm sound. High pitched continuous note.

Mats. Two types are available. (i) Aluminium foil: the top mat is perforated, the bottom one plain; press stud connections (Fig. 8). (ii) PVC/braided wire: the electrodes are braided copper strips affixed to the upper surface of each PVC mat (Fig. 9); the top mat is perforated, the bottom one plain; both mats have eyelets for taping under the mattress.

The PVC mats are very pliable and should be suitable for the restless sleeper; they are claimed to have long life, and should last for six months; the arrangement of the braided wires makes false alarms due to contact between mats unlikely.

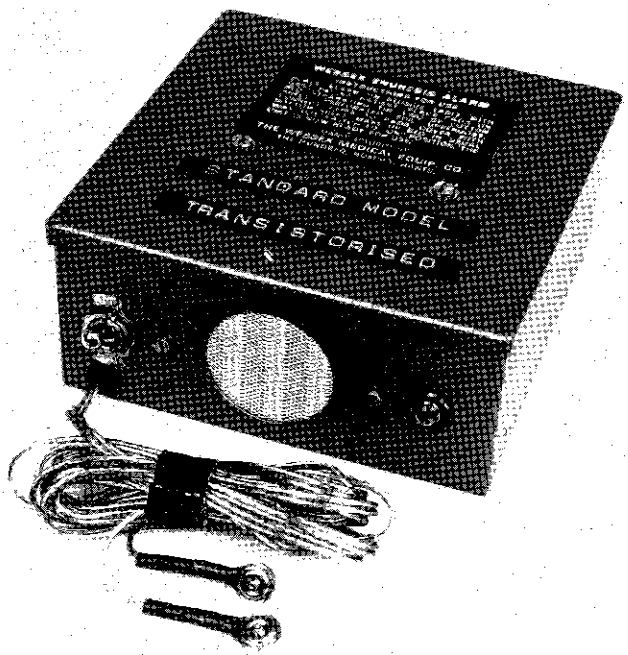

Fig. 7. Wessex Alarm Unit.

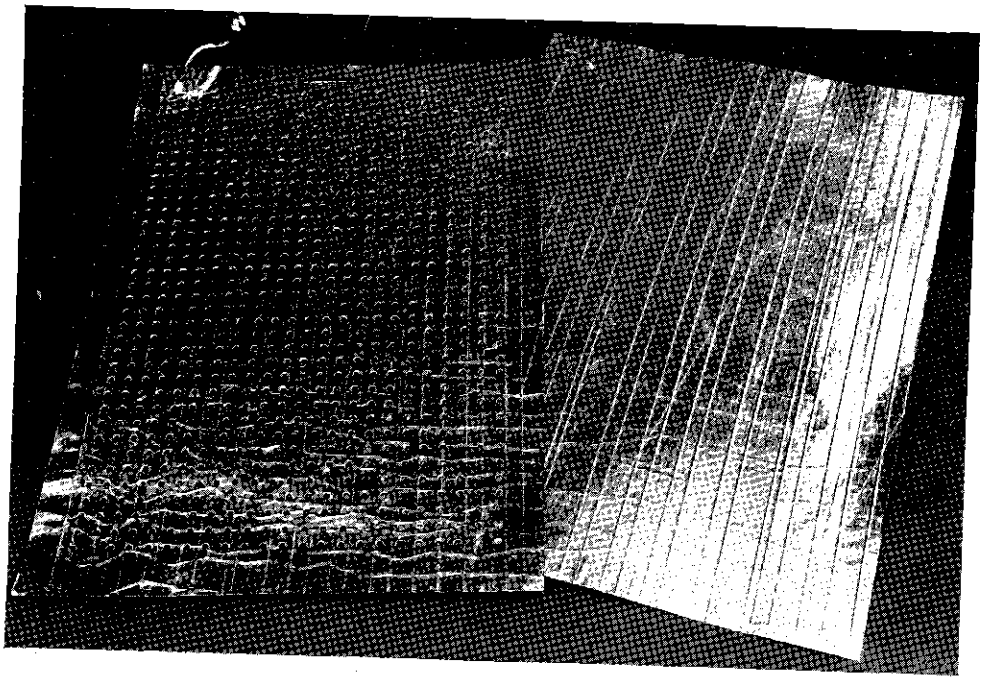

Fig. 8. Wessex foil mats.

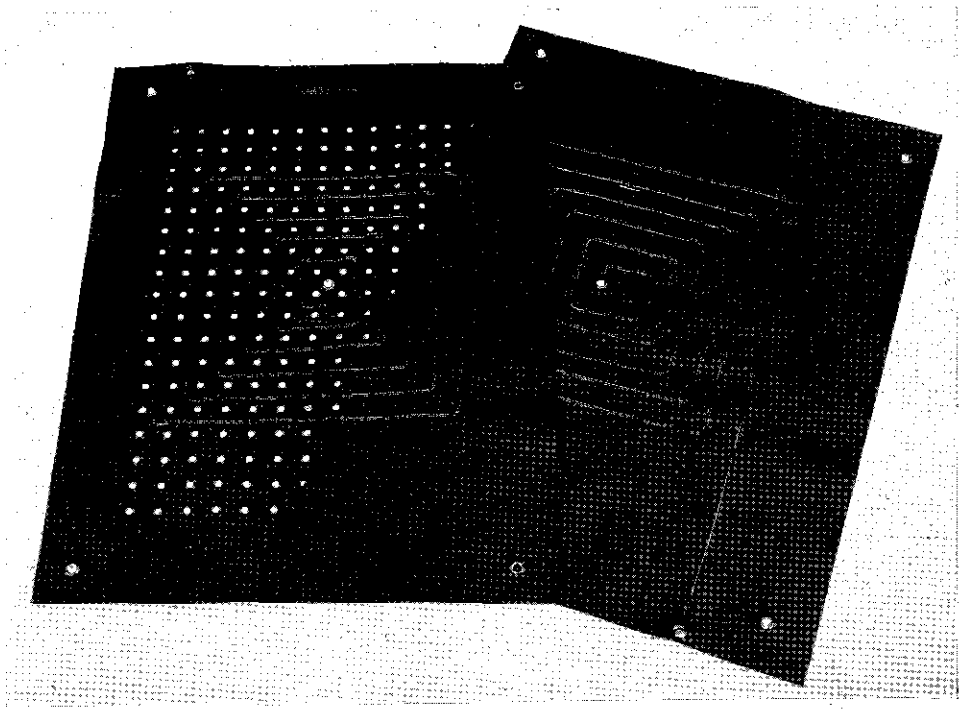

Fig. 9. Wessex PVC mats.

Cost. Complete alarm (unit + mats), with two pairs of foil pads or one pair of PVC pads: £6.50. Mats per pair: (i) foil 0.30p; (ii) PVC/braided wire £1.25.

IV. Chiron Mk II Transistorised Alarm to MOH Performance Specification

Obtainable from Down Bros. and Mayer and Phelps Ltd., Church Path, Mitcham, Surrey. (Data taken from manufacturer's leaflet).

Case. Metal; 'on/off' switch; light; test button; 996 battery.

Mats. Patented bonded foil; top mat perforated, bottom mat plain.

Cost. Unit plus two pairs of patented bonded foil sheets £14.20. Two pairs of foil sheets £3.30; one pair £1.85.

V. Apparatus Obtainable From Occupational Workshops

Quarrier's Homes, The Colony, Bridge of Weir, Renfrewshire.

Mats. Two sheets of foil, the upper with holes in it, stitched to a piece of cotton.

Cost. Unit plus mats: (i) £7.50; (ii) £6.50 when supplied to hospitals and clinics. Mats £1.20 per pair.

(Above information extracted from letter in reply to enquiries.)

NOTE. The prices quoted in this Appendix are those prevailing at the time of writing. Since then, some of these products have been subject to price increases, and Value Added Tax is also payable in the United Kingdom.

Acknowledgements. I should like to thank Dr. A. B. Stewart, Medical Adviser, Inner London Education Authority, for his encouragement.

Thanks are due to Dr. R. M. Forrester for providing Figure 3. I am very grateful to Mr. H. Eastwood for advice and help over the years, and to Mr. S. Spiers of Astric Products Ltd., and Mr. R. Warwick-Smith of the Wessex Medical Equipment Co., for the time they have generously spent in demonstrating their models and answering my queries. Photographs of the alarm devices were kindly supplied by the manufacturers.

REFERENCES

Borrie, P., Fenton, J. C. B. (1966) 'Buzzer ulcers.' *British Medical Journal*, **2**, 151.

Davidson, J. R., Douglass, E. (1950) 'Nocturnal enuresis: a special approach to treatment.' *British Medical Journal*, **i**, 1345.

Dische, S. (1971) 'Management of enuresis.' *British Medical Journal*, **2**, 33.

Forrester, R. M. (1966) 'Buzzer ulcers.' *British Medical Journal*, **2**, 302.

Forsythe, W. I., Redmond, A. (1970) 'Enuresis and the electric alarm: study of 200 cases.' *British Medical Journal*, **1**, 211.

Fraser, M. S. (1971) 'Difficulties encountered in buzzer training.' *Communication at the Newcastle Colloquium.*

—— (1972) 'Nocturnal enuresis.' *Practitioner*, **208**, 203.

Freyman, R. (1963) 'Follow-up study of enuresis treated with a bell apparatus.' *Journal of Child Psychology and Psychiatry*, **4**, 199.

Gillison, T. H., Skinner, J. L. (1958) 'Treatment of nocturnal enuresis by the electric alarm.' *British Medical Journal*, **2**, 1268.

Turner, R. K., Young, G. C. (1966) 'CNS stimulant drugs and conditioning treatment of nocturnal enuresis. A long-term follow-up study.' *Behaviour Research and Therapy*, **4**, 225.

—— —— Rachman, S. (1970) 'Treatment of nocturnal enuresis by conditioning techniques.' *Behaviour Research and Therapy*, **8**, 367.

Young, G. (1969) 'The problem of enuresis.' *British Journal of Hospital Medicine*, **2**, 628.

—— Turner, R. K. (1965) 'CNS stimulant drugs and conditioning treatment of nocturnal enuresis.' *Behaviour Research and Therapy*, **3**, 93.

—— Morgan, R. T. T. (1972) 'Overlearning in the conditioning treatment of enuresis.' *Behaviour Research and Therapy*, **10**, 147.

—— —— (1973) 'Analysis of factors associated with the extinction of a conditioned response.' *Behaviour Research and Therapy*, **11**, 219.

White, M. (1968) 'A thousand consecutive cases of enuresis. Results of treatment.' *Medical Officer*, **120**, 151.