Archives of Disease in Childhood, 1989, **64**, 651–656

Original articles

Controlled trial of standard pad and bell alarm against mini alarm for nocturnal enuresis

K E FORDHAM AND S R MEADOW

Department of Paediatrics and Child Health, St James's University Hospital, Leeds

SUMMARY Fifty six children aged from 6–16 years who wet their beds at night were entered into a controlled trial of two alarm devices: a traditional alarm using a wet sensor mat on the bed attached to an alarm bell out of reach of the child, and a mini alarm system incorporating a tiny perineal wet sensor attached to a small alarm worn on the child's clothing. A quota allocation system ensured comparability between the two treatment groups. The children were encouraged to use the alarm for four months. Both alarms were equally effective in helping children to become dry. There was no significant difference between the number of children unable to comply with treatment or to be helped by each alarm. The rate of acquisition of dryness was similar for the two groups. The traditional standard alarm was sturdier, more dependable, and easier to maintain, but the mini alarm had some advantages, particularly for girls. Both types of alarm are recommended for general use.

Enuresis alarms are popular and successful treatments for children who wet their beds. Most systems rely upon the original 'pad and bell' arrangement, in which a detector pad or mat is put beneath the sleeping child and connected to an alarm that rings as soon as the detector mat becomes wet.[1] Recently different systems have been developed in which a small wet sensor is placed near the child's perineum and is connected to a mini alarm attached to the child's clothing. When using the latter alarm the child does not have to get up out of bed in order to stop the bell ringing. There has been speculation that the smaller more convenient alarm might not be as effective as the standard alarm that forces the child to get out of bed to stop the alarm.

The aim of this study was to evaluate the relative merits of two different alarm systems and to assess the problems that the children, their parents, and their helpers experienced when using the alarms.

Subjects and methods

The trial was conducted in healthy children aged from 6–16 years who had been referred to the enuresis clinic in the children's outpatient department of a large teaching hospital by general practitioners, clinical medical officers, consultant paediatricians, or urologists. The two doctors at the clinic were a consultant paediatrician who had extensive experience of managing enuresis and a clinical assistant/general practitioner who had no previous experience of treating enuresis, though she did have previous experience as a paediatric house officer.

The only children excluded from the trial were those with significant mental handicap (intelligence quotient less than 70), those with a serious systemic or psychiatric disorder, or those who had had a urinary tract infection during the previous two weeks. Fifty six children were enrolled in the trial. For each child bed wetting was a serious problem causing at least two wet nights weekly; most of them wet their beds five or more times a week.

At the initial visit a full history and physical examination was performed including examination of a fresh urine sample for infection or chemical abnormality. Specific enquiry was made about factors known to influence the outcome of treatment for enuresis.[2] These included: housing difficulties, family difficulties, or behavioural abnormalities assessed by scoring a Rutter A questionnaire.[3]

Throughout the trial the children were asked to keep written records (with the help of their parents) of wet and dry nights. A four week base line observation period was started. At the end of that time they were given an enuresis alarm—either a standard Eastleigh SM1 or a Mini Dri-Nite, accord-

ing to a quota allocation system.[4] This allocation system enabled matching groups to be derived by allowing for sex, age groups (6–9 years and 10–16 years), Rutter A score (below 18 and 18 or above), and presence or absence of housing or family difficulties.

The child and accompanying parent were shown by the doctor how to use the alarm correctly, and instructed how to record wet and dry nights on a chart. It was emphasised that during the time that the alarm was used no other treatments such as drugs, 'lifting', or fluid restriction should be used.

The children were seen one week after the alarm had been issued and subsequently every two or three weeks according to response. At each visit the number of dry nights/week was recorded from the child's written record, as were any problems experienced with the alarm. All children were seen by one of the two doctors participating in the trial in order to provide consistency of advice and continuity of care.

Cure was defined as six consecutive weeks without a wet bed; at that point the alarm was removed. It was intended that the maximum period for using an alarm would be four months but extension to six months was permitted for children who were still showing some improvement after four months with the alarm.

At the end of the trial the two groups of patients were compared using the Statistical Package for the Social Sciences (SPSSX) mainframe computer program to assess the outcome of treatment in terms of numbers of dry nights achieved/week and the rate of achievement of dryness. Comparison of incidence of factors in the two groups was assessed by the χ^2 test.

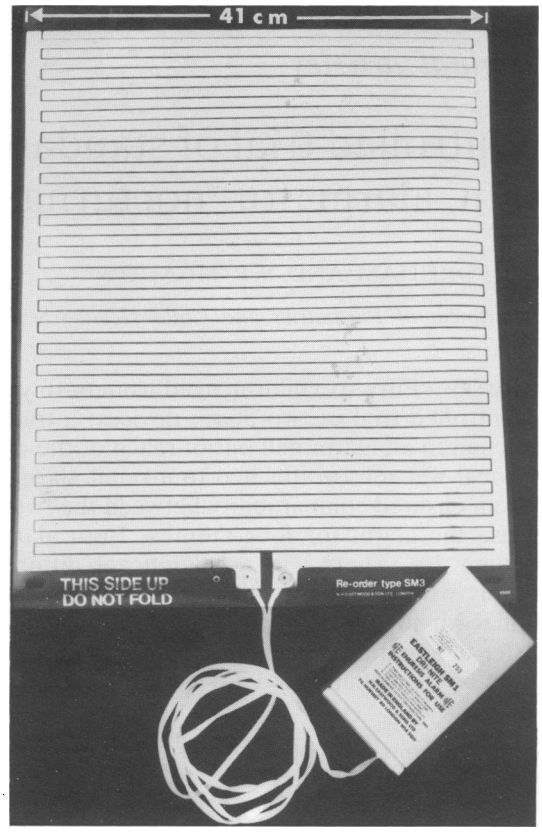

Fig 1 *The standard Eastleigh SM1 (pad and bell) alarm. The plastic mat contains a printed circuit connected by a lead to the alarm box, which is placed out of reach of the sleeping child.*

ENURESIS ALARMS

Two different Eastleigh* alarms were used, both of which are currently available. The standard SM1 alarm (fig 1) has a battery operated alarm box that is connected by a flexible lead to a single large plastic detector sheet (resembling a rear windscreen heater in a car). The detector sheet is placed on the child's bed on top of any protective mattress cover but under the bottom cotton sheet on which the child sleeps. The alarm is placed on a chair or cupboard near, but out of reach of, the child. The alarm is switched to the 'on' position at bed time. The child is advised to sleep naked from the waist down so that the first urine passed will reach the detector sheet speedily causing the alarm to sound. The alarm box also emits a flashing red light. The child is instructed to awaken fast, get out of bed, switch off the alarm, and go to the toilet to pass any remaining urine. The bed is then remade and the alarm reset.[5] The SM1 alarm requires a 9 volt battery, types PP3B, 6F22, MN1604, 6AM6, PP35 or 6LF22. The Mini Dri-Nite alarm (fig 2) consists of a much smaller battery driven alarm unit, a lead, and a tiny wet sensor. The sensor is placed inside a mini pant liner (for example, a 'carefree' panty shield, which is easy to peel apart from the waterproof backing and which accommodates the wet sensor easily). The pad is worn inside the underpants or knickers. The small alarm unit has a Velcro self adhesive cloth attachment that is attached to the front of the chest of the child's night clothes. The wet sensor in the pad responds to urine and triggers the alarm, which emits a high pitched sound. The child is advised to awaken fast and visit the toilet to void. Although the alarm noise can be cancelled by depressing a button on the side of the unit, the alarm sounds again when the button is released unless the sensor has been

*Eastleigh alarms: N H Eastwood and Son Ltd, 7 Nursery Road, London N14 5QH.

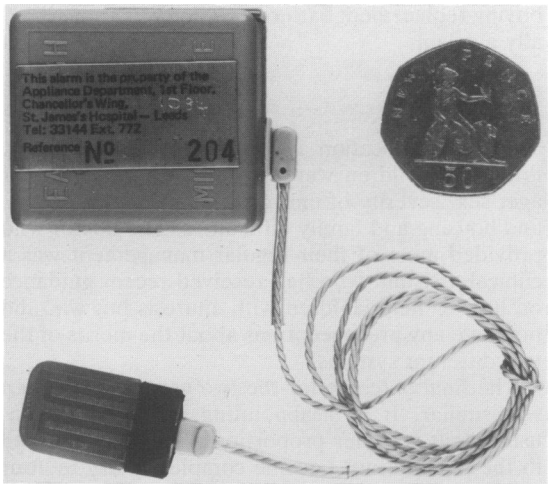

Fig 2 *Mini Dri-Nite alarm. The wet sensor disk, which is fitted into a panty pad, is connected by a lead to a tiny alarm box worn on the child's chest.*

carefully dried. The child and parents are therefore instructed to rinse the wet sensor in water and to dry it before replacing it in a clean panty shield. The Mini Dri-Nite is powered by a small 5,6 volt battery, type 7H34. The cost of the SM1 alarm (October 1988) was £37·00 plus VAT and postage, and that of the Mini Dri-Nite £32·00 plus VAT and postage. There is a 10% discount on orders of 100 or more. 'Carefree' panty shields cost 85p for 20 from many large stores and chemists.

Results

Twenty seven children were allocated to use the SM1 alarm and 29 to use the Mini Dri-Nite (table 1). The quota allocation system permitted the even matching of the groups for most factors likely to affect outcome. Although seven children using the Mini Dri-Nite had behavioural abnormalities (as defined by Rutter scores of above 18) compared with only four using the SM1 alarm that difference was not significant. The two groups of children had almost identically severe bed wetting, and during the four weeks preliminary observation period had a mean of 5·2 wet nights/week.

To compare outcome, the number of dry nights/week for a two week period were counted at fixed intervals throughout the trial. The mean number of dry nights/week at these monthly intervals are shown for each group in fig 3. Those using the SM1 alarm who increased their number of dry nights/week from 1·7 to 6·2 had a similar rate of achievement of dryness to those who used the Mini Dri-Nite, who as a group increased their mean number of dry nights from 1·9 to 6·6. Within the trial period four children who had used the SM1 alarm and six who had used the Mini Dri-Nite had had six weeks completely dry. For those who achieved this 'total cure' the average time of 15 weeks for achievement of cure was similar for the two groups. Most of the families who dropped out of the trial did so during the first two months. As expected the 'drop outs' included an excess of families who had family problems, or children who had Rutter scores of above 18. The quota allocation system had ensured

Table 1 *Characteristics of children allocated to either standard or mini alarm. Figures are expressed as number (percentage)*

	Standard pad and bell alarm (n=27)	*Mini alarm system (n=29)*
Sex:		
Male	18 (67)	21 (72)
Female	9 (33)	8 (28)
Age (years):		
6–9	18 (67)	19 (66)
10–16	9 (33)	10 (34)
Rutter score:		
<18	23 (85)	22 (76)
≥18	4 (15)	7 (24)
Family problems:		
Yes	8 (30)	9 (31)
No	19 (70)	20 (69)
Housing problems:		
Yes	1 (4)	0
No	26 (96)	29 (100)
No of wet nights/week	5·2	5·2

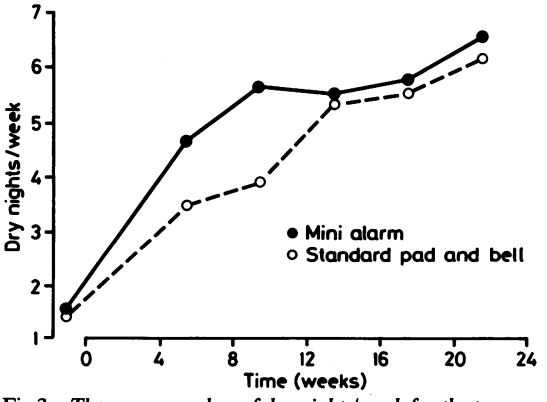

Fig 3 *The mean number of dry nights/week for the two groups using the mini alarm and the standard pad and bell. The alarms were issued at time zero.*

that these patients were equally distributed between the two groups, and of the 21 who had dropped out of the trial 10 came from the SM1 group and 11 from the Mini Dri-Nite group. There was no difference in the persistence (or lack of persistence) in using the respective alarms; the type of alarm did not affect the drop out rate.

The advantages and disadvantages of the alarms as reported by the parents and noted at the clinic are shown in table 2. The bulky SM1 alarm was robust, easy to maintain, and convenient (though at times embarrassing because of its size). False alarms were common, probably associated with the child sweating; the detector mats had a limited life and, for a third of the children, wore out within three weeks.

The Mini Dri-Nite was a small and convenient device that the child could easily take on holiday or to a friend's house without embarrassment. Despite its sensitivity, false alarms were rare; it did not require expensive replacement wet sensor mats. It was, however, not as robust, and frequently the system did not seem to be working. In some cases this was because the wet sensor fell out of the pant liner, in others the stream of urine seemed to miss the wet sensor, and until the manufacturers modified the alarm it was common for the leads to become detached from the alarm. The Velcro attachment for fixing the mini alarm to the child's nightwear was useless. Parents had difficulty in buying replacement batteries, which were not generally available.

Discussion

The quota allocation system ensured that the two groups of children were satisfactorily matched for age, sex, severity of enuresis, behaviour problems, and housing and family difficulties. The doctor who provided most of their regular management was a clinical assistant who had received recent guidance on how to help children with enuresis but who did not have any preconceptions about the merits of the two different systems.

The final outcome for the two groups of children was similar. It is disappointing, and perhaps unusual, that a higher proportion of children entered in the trial did not become completely dry by four months. Factors militating against better results, however, were that this clinic attracts a large number of patients who are difficult to treat and children who have failed other courses of treatment from other health districts. Moreover, our definition of cure is unusually stringent, requiring the child to be completely dry for six consecutive weeks. It is noteworthy that even for those children who did not achieve 'cure', the number of dry nights increased steadily during the period that they used the alarm, and both children and their parents were well pleased with that improvement. For a child who

Table 2 *Advantages and disadvantages reported by users of standard alarm (n=27) and mini alarm (n=29)*

	Advantages	*Disadvantages*	
Standard pad and bell	Comfortable to use	False alarms	(n=11)
	Batteries easy to replace	Detector mats wore out fast	(n=8)
	Alarm box robust: few breakdowns	Child switched alarm off and went back to bed	
		Child has to be naked below waist	
		Large device difficult to conceal	
Mini alarm	Small and unembarrassing	Alarm box Velcro fastening useless	(n=29)
	False alarms rare	Leads detachable from alarm	(n=7)
	Comfortable, particularly for girls	Sensor falls out of pant liners	(n=6)
	Sensitive	Expense of pant liners	
	Wet sensor is reusable and has long life	Batteries difficult to purchase	
	Less expensive	Boys' urine stream missed wet sensor	
		Many inexplicable breakdowns	

previously had only one or two dry beds a fortnight to have 11 or 12 dry beds a fortnight makes life a lot better.

For the purpose of this study we have assumed that those who failed to attend and dropped out of the trial are treatment failures because the experience is that, though a minority of those who fail to attend are subsequently found to have stopped wetting—and that is the reason for their non-attendance—most have dropped out because they find the alarm too awkward to use or lack family support, and are still wetting.[6 7] The number of 'drop outs' was considerable and—as is usually the case—they occurred early on. Thus by four weeks 23% had dropped out. For those who persisted with the alarm, both alarms were equally helpful.

Interestingly, there was no obvious difference in the results of treatments between the two alarm systems, given their different operating requirements. With the SM1 alarm placed out of reach, the child had to awaken thoroughly and get out of bed to stop the alarm ringing. With the mini alarm, although the children are advised to get up when the alarm sounds and to wash and dry the sensor, it is possible for the child, still in bed, to disconnect the alarm from ringing by pulling out the lead. Moreover, other forms of successful treatment of enuresis including 'dry bed training' seem to succeed because of the repetitive and demanding nature of the awkward tasks set for the child in the middle of the night.[8 9] It is as if the child becomes dry quicker if the regimen is more awkward. We had feared that the more convenient mini alarm might be less effective than the standard pad and bell alarm.

The acceptability of the different alarm systems to children, their parents, and those who are trying to help them is most important. As usual we found that the single factor that caused most trouble for the families was unreliability of the product. With all enuresis alarms there are serious problems for the users. The alarms are not as durable as one would wish and, particularly for a clinic that is regularly lending out alarms, durability is of great importance.[10] Inevitably there is always an element of misuse of equipment by children and their families. Detector mats need to be extremely strong and sturdy, for it is disappointing when they disintegrate too rapidly. The SM1 mat is better than most of the others that are on the market, but nevertheless for some children who wet their beds a great deal and who have sagging beds in which the mats get creased, the mat can wear out within three weeks. Leads that become disconnected easily are a worse problem. It is important for replacement batteries to be easily available. The tiny 5,6 volt battery (type 7H34) which powers the Mini Dri-Nite is not easy to obtain from general stores but is available from camera shops or with the help of hospital supplies departments. The SM1 alarm is powered by a larger 9 volt battery, which is available in several different makes all of which are compatible and easy to get.

Most standard pad and bell alarms, including the SM1 system, are associated with frequent false alarms as we found in this trial.[11] Apart from a crumpled mat a common reason for false alarms seems to be excess perspiration, and though one may advise the child to have less bedding and to open the bedroom windows, and the mother to put a thicker piece or a double folded piece of cotton material over the detector mat (or enclose it in a pillow case), false alarms continue to be a problem with most detector mats. False alarms are discouraging for everyone and the child feels cheated at being awoken when he is not wet. The relative absence of false alarms with the Mini Dri-Nite was therefore most welcome. It was difficult to be sure of the precise reasons for the frequent failure of the Mini Dri-Nite device. At times it was clear that the leads were becoming detached or that the alarm box itself was not working. At other times, however, we were not clear where the fault lay and merely issued another Mini Dri-Nite complete with wet sensor. A more reliable Mini Dri-Nite system would be welcome.

By the end of the trial we considered that the Mini Dri-Nite alarm was slightly more suitable for girls, firstly because its perineal sensor was not as acceptable to older boys and, secondly, because of the way that the boys' urine stream sometimes missed the wet sensor. For all children the compactness of the mini alarm was an advantage; they could hide it away in their bedroom when friends were with them. The wet sensor was sensitive and reliable but could be awkward to insert in a panty pad. We are aware of the enuresis alarm that is sold in the United States, and which relies on just two clips fixed to the pants of the child rather than to any specific sensor pad. If that is as reliable as a sensor pad it is likely to be more convenient.

One of the main problems with the Mini Dri-Nite is the inconvenience of the alarm attachment. There needs to be a secure, simple method by which the alarm can be clipped or pinned onto the child's pyjama jacket or T-shirt. The Velcro attachments did not hold the alarm effectively on the child's nightwear.

For any clinic regularly dealing with enuretic children it is worth becoming experienced in the use of more than one alarm, so that if an alarm does not suit a particular family a change in equipment can be made. We find that some children who do not get on

well with the SM1 alarm fare much better with the mini alarm and vice versa, but our trial did not highlight any predictive factors. We believe that it is worthwhile for a clinic to have stocks of both types of alarm. It is probably unwise for clinics, other than the largest and the most specialised, to have more than two types of alarm because it is better for the staff to become really skilled and familiar with the equipment, and they cannot do that if there are many different types of alarm. Moreover, maintenance and provision of spare parts becomes awkward with too many different types of equipment.

We thank Sister June Wilson and the nursing staff for their help in the clinic and Mrs Wendy Pearson for her work with this manuscript.

References

[1] Mowrer OH, Mowrer WM. Enuresis: a method for its study and treatment. *Am J Orthopsychiatry* 1938;**8**:436–59.
[2] Dische S, Yule W, Corbett J, Hand D. Childhood nocturnal enuresis: factors associated with outcome of treatment with an enuresis alarm. *Dev Med Child Neurol* 1983;**25**:67–80.
[3] Rutter M, Tizard J, Whitmore K. *Education, health and behaviour*. London: Longmans, 1970.
[4] McGuire R. Quota allocation. *J Psychosom Res* 1968;**12**:168–9.
[5] Meadow R. *Help for bedwetting*. Edinburgh: Churchill Livingstone, 1980.
[6] Meadow R. Practical aspects of the management of nocturnal enuresis. In: Kolvin I, MacKeith RC, Meadow SR, eds. *Bladder control and enuresis*. London: Heinemann, 1973.
[7] Young GC, Morgan RTT. Childhood enuresis: termination of treatment by patients. *Community Med* 1972;**129**:247–50.
[8] Azrin NH, Foxx RM. *Toilet training in less than a day*. New York: Simon and Schuster, 1974.
[9] Azrin NH, Sneed TJ, Foxx RM. Dry-bed training: rapid elimination of childhood enuresis. *Behav Res Ther* 1974;**12**: 147–56.
[10] Goel KM, Thomson RB, Gibb EM, McAinsh TF. Evaluation of nine different types of enuresis alarms. *Arch Dis Child* 1984;**59**: 748–53.
[11] Meadow R. How to use buzzer alarms to cure bed wetting. *Br Med J* 1977;**ii**:1073–5.

Correspondence to Professor S R Meadow, Department of Paediatrics and Child Health, St James's University Hospital, Beckett Street, Leeds LS9 7TF.

Accepted 21 October 1988