

# Electro-acupuncture in the Treatment of Children with Monosymptomatic Nocturnal Enuresis

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**Objective:** The aim of this study was to investigate the effects of a long series of electro-acupuncture (EAP) sessions on bedwetting symptoms. **Material and methods:** Twenty-five children (age range 7–16 years) with monosymptomatic nocturnal enuresis and treated earlier without success were included in the study. The median number of wet nights per week was 4.7 before treatment. Bedwetting, voided volume, sleep and nocturia were evaluated 3 weeks, 3 months and 6 months after 20 sessions of EAP lasting 8 weeks. **Results:** All the children, with the exception of one, tolerated EAP treatment well. At the three follow-up sessions it was found that the number of dry nights had increased gradually from a median of 2.3 in the pre-test to 3.0, 4.3 and 5.0 per week, respectively. Compared to pre-treatment findings there were more dry nights in 65% of the children ( $p < 0.001$ ) and 5 out of 23 children were responders ( $> 90\%$  reduction of the numbers of wet nights) at the 6 months' follow-up. According to the parents, the sleep arousal threshold had decreased in about 50% of the children.

**Key words:** child, electro-acupuncture, nocturnal enuresis, urinary incontinence.

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Monosymptomatic nocturnal enuresis (MNE) is the most common type of incontinence in childhood. The prevalence differs because of differences in diagnostic criteria. Among 7-year-old children 7–10% suffer from nocturnal enuresis, predominantly boys (1, 2). The rate of spontaneous cure is about 15% per year and 0.5–1% are still enuretic into adulthood (3, 4).

The pathogenesis of bedwetting is multifactorial. One cause is lack of circadian rhythmicity of anti-diuretic hormone secretion, resulting in high nocturnal urine production (5). Enuretic children are described by their parents as deep sleepers and do not wake up prior to or during urination (6, 7). A possible cause can be a deficit or defect in the arousal mechanism (8). Another factor of importance is bladder dysfunction. Hold pattern syndrome during day-time indicates an unstable bladder during night-time (9).

The first treatment of choice with documented efficacy is an alarm system, aimed at arousing the child at the first appearance of urine in the bed and conditioning him to wake up in order to void. This treatment has a success rate of 75% but with a relapse rate of 20–40% (6). When the enuresis alarm is not suitable or unsuccessful, a vasopressin analogue, desmopressin (DDAVP), can be used to decrease the urine production during night-time. In a study of 399

enuretic children treated with DDAVP, 61% were responders and 18% were cured (10). Bladder rehabilitation during day-time has been used with success as an adjunct to the alarm system and DDAVP (9).

Some enuretic children do not respond to any of the conventional treatments. In these cases alternative treatment methods have been used. A new method is rapid maxillary expansion. This method is based on the assumption that an upper airway obstruction may be the cause of enuresis (11).

Acupuncture (AP) has been used with varying degrees of success. According to Chinese reports, 73–100% of patients were cured (12–14). In a European study electro-acupuncture (EAP) gave a statistically significant decrease in enuresis episodes in 30% of the children (15). In another EAP study the success rate was 98.2% (16). Minni et al. (17) also reported that good results had been seen in subjects treated with EAP. In a controlled study DDAVP combined with AP was more effective than AP, DDAVP or placebo, given separately (18). In a study of patients with irritative bladder symptoms the participants were randomly selected to anticholinergic therapy or AP treatment. The two treatments were equally effective but AP showed fewer side-effects (19). The favourable results reported after EAP treatment in enuretic patients

Table I. *Others methods used before EAP (n = 24)*

	Alarm system <i>n</i>	DDAVP <i>n</i>	Tricyclic anti-depressants <i>n</i>	Maxillary expansion <i>n</i>	Other methods <sup>1</sup> <i>N</i>
Yes, once	10	23	2	3	2
Yes > once	10				
Never	4	1	22	21	22

<sup>1</sup> Spinal morphine and AP.

prompted us to investigate the effect of a long series of EAP sessions in children and adolescents with MNE.

## MATERIAL AND METHODS

### Subjects

The participants were recruited consecutively by the paediatricians who had been consulted by the parents of children and adolescents (ages 7–16 years), because they were still enuretic despite treatment efforts. After careful examination and investigation, children diagnosed with MNE and with more than 10 wet nights/month were asked to participate in the study. Exclusion criteria were daywetting, urinary tract infection, urgency and frequency (>7 micturitions per day) and allergy to nickel.

Twenty-five children and adolescents (20 males and 5 females) were included in the study after informed consent. One boy withdrew early. The mean age of the remaining children was 10.3 years, median age 10.0 years, range 7–16 years. Two of the boys (9 and 11 years old, respectively) had secondary enuresis and the remainder had primary enuresis.

All the children had been treated for bedwetting at least once, with conventional methods (Table I). Five children did not use DDAVP because of fear of drugs despite four of them being responders. During the study none of the children received any other form of treatment for bedwetting.

### Study design

The design of the study is presented in Fig. 1. During the pre-treatment period as well as in the three post-

treatment periods the parents kept diaries and noted the following parameters.

- 1) Frequency of dry and wet nights, and amount of wetting, expressed as *slightly wet* (size: a coin), *wet* (size: ≤30 cm) or *very wet* (size: >30 cm). At the 3 and 6 months' post-treatment tests the parents were only subjectively estimating the amount of wetting.
- 2) Voided volume: the first voided volume in the morning after two dry respectively two wet nights.
- 3) Sleep and nocturia: subjective depth of sleep, i.e. how difficult it was for the parents to waken the child and the frequency of nocturia and/or waking up when wetting episodes occurred.

Asking the parents if they or the siblings of the child had had nocturnal enuresis stated the heredity.

### Preparation

Before the pre-treatment period the children were given written instructions to drink, eat and void regularly.

A preparation programme started with some brief information about AP and the children looked at and handled the AP needles. The nurse demonstrated the procedures of AP on an AP doll and the children were encouraged to puncture the doll. The AP doll was available during the all the treatment sessions.

### Electro-acupuncture treatment

The treatment consisted of 20 sessions, with the child in supine, relaxed position. Three sessions were given weekly during the first three weeks and then two sessions per week. The EAP sessions lasted 30 min. Seven sterile disposable steel needles, size 0.20 mm

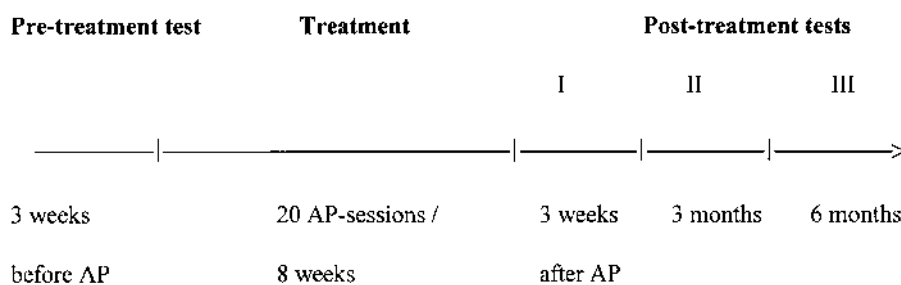


Fig. 1. The study design. Pre-test and post-test periods lasted 3 weeks.

× 15 mm or 0.30 mm × 30 mm were used. Six of the needles were placed bilaterally in acupoints innervated by the sacral segments S<sub>2</sub>–S<sub>4</sub>, which are the origins of the sacral parasympathetic output. The needle sensation, deqi, was striven for at all locations. To minimize soreness/pain caused by tissue damage, two different groups of acupoints were used alternately. Group 1: bilateral SP 6\*, BL 60\*, LIV 3 and CV 3. Group 2: bilateral K 3\*, SP 9\*, ST 44 and CV 4. All selected points were situated in feet and legs, except CV 3–4, which are located below the umbilicus (20). Following initial manual stimulation (three sessions), two pairs of needles (marked\*) were connected to an electrostimulator (CEFAR acus, Cefar Medical AB, Lund), giving biphasic square-shaped pulses with low frequency (2/15 Hz.). The current was of painless intensity but produced moderate muscle spasms. Before each session the child was asked to urinate. During the sessions the child was offered the opportunity to read or to listen to fairy stories through earphones.

#### Drop out

Twenty-four out of 25 children completed the treatment. One 7-year-old boy dropped out after two sessions because of fear of the needles. This boy did not differ otherwise from the other subjects. Another subject, an 11-year-old boy, did not participate in the 3 months' follow-up. His parents wanted to restart treatment with a body-worn alarm system, because they subjectively had noticed that it was easier to waken him up after the EAP treatment. The boy became dry after two weeks of treatment with the alarm system and was still dry at 6 months' follow-up.

#### Statistics

The results of the study were computerized and analysed with the Statistical Package for Social Sciences (SPSS), version 6.1.3. A non-parametric statistical method, the Wilcoxon matched-pairs signed-ranks test, was used to compare the results of individual patients before and after treatment.

The outcome of the EAP treatment was evaluated according to the standardization and definitions in lower urinary tract dysfunction in children of the International Children's Continence Society (ICCS). *Responder* is defined as having a >90% reduction in the number of wet nights; *partial responder* means having a >50% reduction in the number of wet nights; *non-responder* indicates having a <50% reduction in the number of wet nights (21).

The Research Ethics Committee, Faculty of Health Sciences, Linköping University, approved the study.

## RESULTS

The children had a family history of enuresis, with 29% in the fathers, 25% in the mothers and 29% in the siblings. Self-care, such as fluid restriction, was used by 33% and waking the child to use the toilet was practised by 63% of the parents. In the parents' opinion, 22 of the 24 children were subjectively deep sleepers before treatment. Seventeen children did not waken up when enuresis occurred. In 2 children the bedwetting occurred once per night before midnight, in 9 children after midnight, at various times per night in 9 of the children and one child did not know. Three children had several enuresis episodes per night, before and after midnight.

All the children, except one, tolerated the EAP treatment well and the compliance was very good. The children were very cooperative and, under supervision, they liked to assist when the needles were taken out.

#### Dry nights

The respective numbers of dry nights during the test periods are listed in Table II. During the treatment period the number of dry nights per week gradually increased from a median of 2.3 in the pretest weeks to a median of 2.7 per week in the first three weeks of EAP treatment to a median of 3.5 in the last three weeks of treatment. The total number of dry nights increased from 155 in the 3-week period before treatment to 237 in the post-treatment test 3 weeks after EAP and 17/24 children had increased the number of dry nights ( $p < 0.001$ ). Four children had fewer dry nights and 3 children showed no change after treatment (Wilcoxon matched-pairs signed-ranks test). At the follow-up 3 months later, 78% (18/23) of the children had more dry nights ( $p < 0.001$ ), 4 children had fewer dry nights and one child showed no change. At the 3- and 6 months' follow-ups after EAP treatment the dry nights increased from a median of 2.3 per week in the pre-treatment test to a median of 4.3, respectively, a median of 5 episodes per week. At the 6-months' follow-up 65% (15/23) of the children ( $p < 0.001$ ) had more dry nights, 4 children had fewer and 4 children showed no change compared with the results of the pre-treatment test.

In accordance with the requirements of the ICCS, the individual outcomes as responders to the EAP treatment are shown in Table II. In total, 7 children were responders in at least one of the follow-up examinations. The children who were non-responders ( $n = 9$ ) at all follow-up tests had fewer dry nights in the pre-treatment period than responders. The responders ( $n = 7$ ) had a mean of 9.4, median 9.0, dry nights per 3 weeks and child and non-responders had a mean of 3.9, median 2.0, dry nights before the treatment; 5 of

Table II. Individual (n = 24) numbers of dry nights in test periods before and after treatment

Sex	Age	Pre-test	Dry nights during period of 3 weeks		
			3 weeks	3 months	6 months
			Post-treatment test		
			Responders at 6 months		
M	8	7	19	21 <sup>1</sup>	21
M	9	9	21 <sup>1</sup>	21 <sup>1</sup>	20
M	9	14	19	18	20
M	11	7	16	21 <sup>1</sup>	21
M	11	9	5	21 <sup>1</sup>	20
			Partial responders at 6 months		
F	9	10	20 <sup>1</sup>	17	19
M	10	0	8	11	17
F	11	5	8	11	17
M	13	10	16	21 <sup>1</sup>	19
M	13	14	10	13	19
M	14	10	17	19	18
			Non-responders at 6 months		
F	7	0	1	9	9
F	8	0	1	1	0
M	8	0	0	0	0
M	8	2	7	10	2
F	8	9	11	16	12
M	9	0	0	2	0
M	9	0	0	(21) <sup>2</sup>	(21) <sup>2</sup>
M	10	4	5	1	1
M	10	4	8	6	8
M	10	13	10	11	12
M	12	12	8	9	10
M	14	4	10	14	3
M	16	12	17	17	15

<sup>1</sup> Responder at that time.

<sup>2</sup> Dropped out because of alarm treatment.

the 6 youngest children (7–8 years old) did not show any improvement. There was no difference in the outcome of the treatment in relation to the child's family history of enuresis.

#### Wet nights

During the 3 weeks' pre-treatment test the mean number of wet nights per week was 4.8 and 54.7% of these were *very wet*, 41.6% were *wet* and 3.7% *slightly wet*. At the 3 weeks' post-treatment test the total number of wet nights decreased from 349 to 267. *Slightly wet* nights increased to 15% and *very wet* nights decreased to 36.3%. At the 3 and 6 months' follow-ups, 43% of the children were estimated as *wet*. Many parents spontaneously told us that it was often only necessary to change the disposable sheet in the morning because the bed was not so wet.

#### Voided volume

The respective voided volumes after dry and wet nights did not differ in the pre-treatment and post-treatment test periods, except in one boy who was one of the responders. Before treatment the boy had nocturia five

times a week and a morning urine volume of about 45 ml after dry nights as well as after bedwetting nights. After treatment he still had nocturia but the urine volume increased to 125 ml.

#### Sleep arousal and nocturia

At the 3 weeks', 3 and 6 months' follow-ups 33%, 52% and 48%, of the parents, respectively, noted in their diaries that the children were easier to wake up. Three children woke up (did not do so before) when wetting episodes occurred. In the last part of the treatment 5 children woke up because of the desire to void and 4 of them voided early in the morning. Two of these children became dry. Three weeks after treatment 17/24 of the children recorded no changes in nocturia. Nocturia episodes changed in two of the responders, in one child from once per three weeks to three times per week and in the other from once to twice per night. Three children without nocturia before treatment had nocturia once a week after treatment. Two children had a decrease in their episodes of nocturia from 5–6 per week to 1–2 per week. One of these boys differed from the other as early as after the first week of treatment and nocturia increased from zero to more than 3 nights per week. He had about six dry nights per week in four weeks and then he became continent. Nocturia was not recorded at the 3- and 6-months' follow-ups.

Four children who did not respond to DDAVP before EAP tried the treatment again temporarily for one weekend between the 3- and 6-months' follow-ups, and this time with a good response.

#### Side-effects

Three parents noted in their diaries that the child sometimes felt drowsy and tired in the afternoon following EAP. One boy complained about soreness (stiffness) in the muscles. Otherwise no complications or side-effects were observed.

## DISCUSSION

In the Western world AP is a well-established treatment for pain. In Sweden the method is also accepted in the treatment of other conditions, but it is not often practised in children. One of the reasons is probably the belief that it is too painful or traumatic for children (22). In this study all the children except one completed the course of treatment, indicating that the EAP treatment was not experienced as unpleasant. There is an increasing demand for non-pharmacological treatment in child healthcare. Many parents are afraid of the side-effects of drugs and prefer other methods (23). For example, in this study 5 out of 25 children did not use DDAVP for this reason. The need for alternative treatments makes it important to

investigate the possible effects of methods such as AP to clarify indications and the degree of effects. Enuresis is a relatively common problem and many children are not helped by conventional methods. All the children in this study had tried one or several methods, without success. EAP has traditionally been used to treat enuresis but only a few reliable studies have been carried out. It therefore seems important to conduct further studies on the effect of EAP in enuresis.

Particular care should be taken when a method is introduced to children (22, 24). The preparation programme that was used in this study made it easy to inform and establish confidence between the children and the nurse. The AP doll was very useful in helping the children to understand the practicalities of the method, particularly for those under 11 years of age.

Acupuncture points were selected in segment S<sub>2</sub>–S<sub>4</sub> in order to influence the spinal micturation centres as well as the parasympathetic innervation to the urinary tract. Several of the points have also been used in other Chinese and Western studies (14, 16, 17).

In the first sessions it was difficult for some children to feel any "needle sensation" (radiating paraesthesia, numbness, etc.) but after a few sessions they were able to identify this sensation. In our experience it is more comfortable and less disagreeable to use electrostimulation than manual stimulation. Added electrical stimulation by means of AP needles has also been found more efficient than manual stimulation (17). There is also evidence that low-frequency stimulation is preferable for bladder inhibition (25).

The number of dry nights increased gradually during the treatment but the most pronounced improvement was seen at the follow-ups. Compared to the pre-treatment period, the total number of dry nights in all children was almost doubled at the 3- and 6-months' follow-ups. Other studies have shown a similar gradual improvement (15, 17). Chinese studies show a more marked improvement and even total cure after only a few AP sessions (12, 13). It is difficult to evaluate the outcome of the treatment in these studies, particularly since AP and other therapies are often combined and AP is given daily. It is also difficult to compare the outcome of our treatment with other AP studies because of differences in definitions of cure, improvement and characteristics of the included subjects, such as resistance to conventional treatment.

The therapeutic effects of EAP seem to be related to the age of the children. The adolescents improved only slightly according to previous studies (13, 16) and our results show that children over the age of 14 did not markedly increase the number of dry nights. In our study 5 of the 6 youngest children (7–8 years old) did not show any improvement, which suggests that EAP

treatment is unsuitable for enuretic children in this age group.

About 50% of the parents noted that it was easier to waken their children in the morning. Another sign of change in arousal after EAP was that some children woke up when the enuresis episode started or because of nocturia. Many types of stimulation, possibly including EAP, influence the noradrenergic projection from the locus ceruleus, which may influence the cortical arousal associated with distension of the urinary bladder (26) as well as the vasopressin secretion. The level of vasopressin may influence the cortical arousal. It has been suggested that children do not waken up with a full bladder because of a deficiency of vasopressin (27).

Before treatment the most common mode of wet nights was *very wet*. This mode decreased and was replaced by the *wet* mode in 20% of the children. Similarly, children with the *wet* mode often changed to *slightly wet*. Thus, the improvement is reflected in smaller volumes of bedwetting. Interestingly, the volumes of bed urination decreased but not the voided volume in the morning. This observation suggests an increased vasopressin production during the night following EAP, giving a decreased urine production and decreased arousal threshold.

It is difficult to compare the results of the present study with those using conventional treatments, since the children included in the study did not improve after treatment with conventional methods. A recently published study (27) compared four treatment groups, observation ( $n = 50$ ), imipramine ( $n = 44$ ), DDAVP ( $n = 88$ ) and alarm system ( $n = 79$ ), in a therapy period of six months. At 6 months' follow-up after treatment the results were: in the observation and imipramine groups 16% of the children were continent, 10% in the DDAVP group and 56% in the alarm system group. Continence was defined as 0 to 1 wet night per month. With the corresponding criteria for continence applied to our study, 21% of the children became continent. This comparison suggests that EAP is an alternative treatment in children who do not respond to an alarm system.

Four children who previously were non-responders to DDAVP treatment became responders after the EAP treatment with the same dose as that used earlier. This observation may be a result of an additional effect of EAP and DDAVP, as suggested in another study using a combined treatment with AP and DDAVP (18).

This study was not randomized, placebo-controlled, and the results should be interpreted with caution. The subjects were probably very motivated to try another therapy because the other methods of treatment had failed. Still, it seems likely that EAP has a specific effect on enuresis, since the increase in the number of dry nights

was gradually increased and the main part occurred after the treatment and lasted for at least 6 months. The reduction in enuresis is considerably greater than that expected from spontaneous improvement (3, 4).

## CONCLUSION

Three and 6 months after EAP treatment, 78% and 65% of the children, respectively had significantly more dry nights than before treatment. Five children became continent and the voided volume in the bed decreased. The parents estimated that the sleep arousal threshold was decreased in 50% of the children. EAP treatment is not a method of first choice but may be used as a complementary treatment, perhaps in combination with other treatments, when the child is resistant to conventional therapies. In a further study it would be interesting to combine treatment with EAP and the alarm system to determine whether these methods may potentiate each other.

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