Timer Watch Assisted Urotherapy in Children: A Randomized Controlled Trial

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**Abbreviations
and Acronyms**

AVV = average voided volume

MVV = maximal voided volume

OAB = overactive bladder

stdU = standard urotherapy

UI = urinary incontinence

Purpose: We evaluated the effect of timer watch treatment in addition to standard urotherapy in children with overactive bladder and daytime urinary incontinence.

Materials and Methods: A total of 60 children with daytime urge incontinence were included in the study. Following a 4-week run-in period of standard urotherapy children were randomized to 12 weeks of standard urotherapy with or without a timer watch. Incontinence episodes were registered and 48-hour bladder diaries were obtained before randomization, and at weeks 1, 11 and 12. Long-term response was evaluated at 7 months.

Results: Two children became continent during the run-in period. Before intervention children in the timer group were slightly more wet than children in the standard urotherapy group (median 7 [IQR 25% to 75% 6 to 7] vs 6 [3 to 7] wet days per week, $p < 0.05$). Following 12 weeks of standard urotherapy children randomized to timer assisted urotherapy had significantly fewer wet days per week (median 2, IQR 25% to 75% 0 to 5) vs those undergoing standard urotherapy alone (5, 2.75 to 6.75, $p < 0.01$). In the timer group 18 children (60%) achieved a greater than 50% decrease in incontinence episodes, compared to only 5 (18%) treated without timer assistance. Nine patients (30%) in the timer group and no child in the standard urotherapy group achieved complete daytime continence. The timer increased compliance with the timed voiding regimen. At 7 months of followup 60% of children in the timer group were still continent in the daytime.

Conclusions: A programmable timer watch significantly improves the effect of standard urotherapy. When using the timer watch as a supplement to standard urotherapy 60% of the children obtained complete and sustainable daytime continence.

Key Words: behavioral therapy; combined modality therapy; urinary bladder, overactive; urinary incontinence; urination

CONSERVATIVE treatment is first line management for nonneuropathic daytime urinary incontinence in children.[1–3] Nonsurgical nonpharmacological treatment for lower urinary tract dysfunction is called urotherapy.[4] In children suffering from daytime urinary incontinence urinary tract infections and defecation disorders must always be ruled out as underlying causes before initiation of urotherapy.[5,6]

Standard urotherapy, the simplest form of urotherapy, encompasses demystification of the disorder, improvement of patient perception of bladder function and structure, teaching proper toilet posture, normalization of fluid intake and toilet habits, support and en-

couragement by the caretaker, and voiding at regular intervals.[4,7] This behavior modifying training approach is widely accepted, although controlled studies of well characterized pediatric populations with daytime incontinence are scarce. Earlier studies have shown an effect of standard urotherapy in children in the range of 6% to 41% for cure and 44% to 64% for improvement.[2,8,9] However, some of these studies included children with lower urinary tract symptoms other than incontinence. The long-term effect of standard urotherapy was reported by Klijn et al, who observed a 12-month cure rate of 44% in children with dysfunctional voiding.[10]

Although the value of a timed voiding schedule is widely accepted, it is a demanding task for the child and depends heavily on factors such as maturation, motivation, and support from the parents and other adults. In a retrospective analysis from a secondary referral center we recently reported a cure rate for daytime incontinence of up to 55% by isolated stdU.[11] Furthermore, 70% of children without initial response to urotherapy achieved daytime continence when a timer watch was added to the standard urotherapy regimen.

Although the positive effect of a timer watch in increasing compliance with a timed voiding regimen seems rational, its exact efficacy has yet to be proved in a randomized controlled fashion. The primary aim of this randomized controlled study was to elucidate the efficacy of a timer watch as a supplement to standard urotherapy for daytime incontinence in children with overactive bladder. We also sought to identify potential prognostic factors for timer response.

MATERIALS AND METHODS

Study Subjects
The study was approved by the local ethics committee and registered at ClinicalTrials.gov (NCT00238680). Children referred for daytime incontinence to the outpatient clinics of the Center for Child Incontinence at our university hospital were considered for participation. Inclusion criteria were age 5 to 14 years, at least 1 episode of daytime incontinence weekly, voiding frequency of 6 or more times daily, overactive bladder (urgency), normal urinalysis, unremarkable kidney and urinary tract ultrasonography, normal clinical examination, no indication of bladder underactivity or lower urinary tract obstruction as assessed by uroflowmetry and no present fecal problems according to Rome III criteria.[4,12] Exclusion criteria were previous treatment with timer assisted urotherapy and/or a history or present use of anticholinergics or alpha-blockers. A total of 61 children were initially included and 7 patients declined participation. These subjects did not differ from the included children with regard to demographics or severity of incontinence. Of the participants 57 (95%) had previously tried stdU without timer watch assistance.

Study Design
The study design is illustrated in figure 1. Children received standard urotherapy, as described previously,[4] including instructions regarding daily fluid intake of at least 1,200 ml equally distributed throughout the day and timed voiding with 2-hour intervals until bedtime. The children were allowed to void at any time in the interim if they had the urge to do so. During the run-in period (4 weeks) children were requested to complete 48-hour bladder diaries and report the number of wet days during week 4.

At the second visit children who continued to experience incontinence episodes once or more weekly were randomly allocated to either timer assisted (timer group) or standard urotherapy (stdU group). Children were provided with a watch with 7 alarms (Triax 35, Nike Inc., Beaverton, Oregon). Registrations of wet days and 48-hour bladder diaries were obtained during weeks 1, 11 and 12. MVV was identified and corrected for age (expected MVV = 30 × age + 30).[4] AVV was calculated and data on voiding frequency, total daily fluid intake and fluid intake before 4 p.m. were obtained.

Compliance with timed voiding was determined from review of the bladder diaries. If 1 voiding interval exceeded 3 hours during at least 3 registered days, children were characterized as noncompliant.

The primary end point was response to treatment appraised by comparing pre-intervention registrations of wet days with mean number of wet days weekly during weeks 11 and 12 of the intervention period. Response to treatment was reported in accordance with International Children's Continence Society standards.[4] Thus, a 0% to 49% reduction in wet days was defined as no response, 50% to 89% as partial response and 90% or greater as response, and complete daytime continence was defined as full response. Secondary end points included age corrected MVV and AVV, total daily fluid intake, fluid intake before 4 p.m. and compliance. For selected parameters change scores were used for comparisons. At visit 3 all children and/or parents were asked to report their subjective opinion of the effect of intervention by multiple choice of "improved," "unchanged" or "worse."

Posttreatment Evaluation
Children randomized to stdU who did not achieve dryness were at the third visit provided with a timer watch for another 12 weeks. All children were offered 2 followup visits within 12 months after the intervention period. At followup visits the number of wet days weekly and usage of the timer watch system were noted.

Statistical Analysis
Based on retrospective studies,[11] the sample size for adequate statistical power of 27 children per group was calculated. Results are reported as mean ± standard deviation or, for parameters that were not normally distributed, as median (IQR 25% to 75%). Student's t test was used for group comparisons. Mann-Whitney rank sum test was used for nonparametric analysis and Fisher's exact test or Pearson's chi-square test was used for distribution comparisons for categorical values. A p value of less than 0.05 was considered statistically significant.
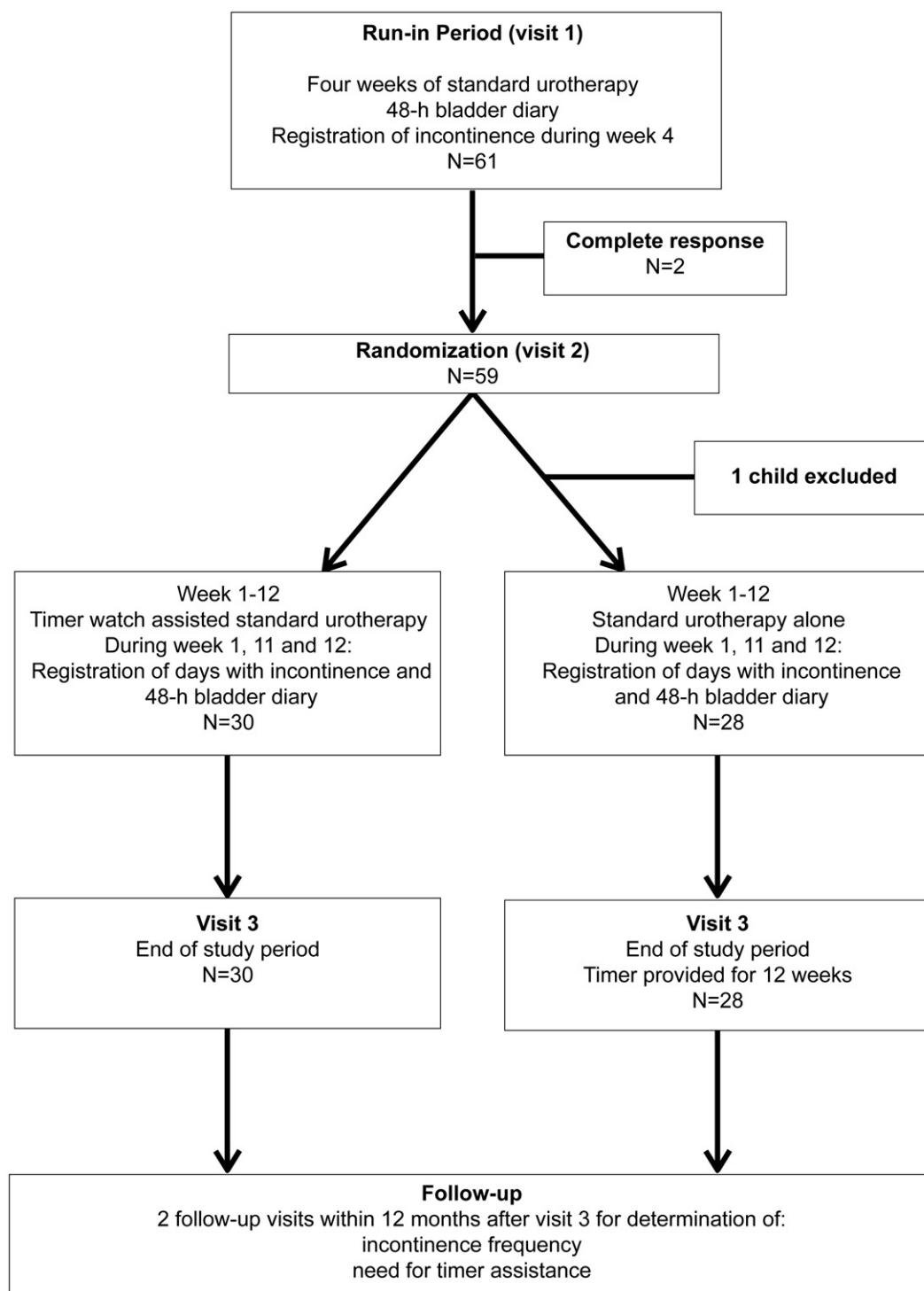
Figure 1. Flowchart of study procedure. Investigation was composed of 3 phases—run-in, randomization and post-intervention followup.

RESULTS

Two children responded fully during run-in and were excluded from study. The remaining 58 children proceeded to the intervention study. Table 1 summarizes demographic and run-in data on the included patients.

Timer Assisted vs Standard Urotherapy

A total of 30 children (mean age 7.48 years) were randomized to timer assisted therapy and 28 (7.65) to standard urotherapy alone. The 12-week intervention period led to a significant treatment response in 18 children (60%) in the timer group. Of

Table 1. *Patient characteristics before treatment*

	stdU Group	Timer Group	All Pts
No. OAB	28	30	60
No. primary UI	23	26	51
No. daytime UI alone	4	4	10
No. daytime UI + enuresis	24	26	50
No. history of fecal problems	6	10	16
No. uroflowmetry:			
Bell-shaped	19	21	32
Tower	7	8	15
Staccato	2	1	3
Significant residual urine	7	10	18
No. gender:			
M	16	21	38
F	12	9	22
Mean ± SD age (yrs)	7.48 ± 1.62	7.65 ± 1.81	7.57 ± 1.71
Mean ± SD body weight	25.6 ± 6.5	28.2 ± 10.3	27.0 ± 8.6
Mean ± SD ht	127 ± 12	123 ± 31	125 ± 24
Mean ± SD incontinence episodes/wk before treatment	8.0 ± 5.2	9.9 ± 6.4	9.0 ± 5.8
Mean ± SD MVV/% expected bladder capacity during run-in	66.7 ± 22.2	73.6 ± 33.1	70.2 ± 28.2
Mean ± SD AVV/% expected bladder capacity during run-in	39.1 ± 12.1	39.1 ± 11.3	39.1 ± 11.6
Mean ± SD incontinence episodes/wk after run-in	5.9 ± 3.6	8.6 ± 4.9	7.3 ± 4.5*
Median wet days/wk after run-in (IQR)	6 (3–7)	7 (6–7)	7 (4–7)*

* p <0.05.

these patients 9 (30%) achieved complete daytime continence, 1 (3%) was a responder and 8 (27%) demonstrated partial response. By comparison, only 5 of 28 patients (18%) in the stdU group had a partial response to stdU alone. No child in this group achieved complete daytime continence. The difference in response between groups was highly significant (p <0.001).

As illustrated in figure 2, children in the timer group achieved significantly more dry days per week compared to children in the stdU group (mean ± SD change in dry days weekly 3.5 ± 2.5 vs 0.6 ± 1.8,
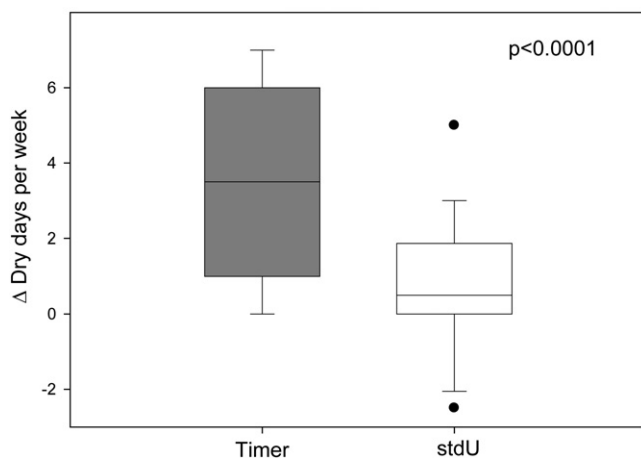
p <0.0001). To elucidate further the progress in continence during the intervention period, median wet days weekly for the 2 groups before, during and after treatment were compared (table 2). The timer group achieved a significant decrease in median number of wet days weekly (from 7 [IQR 25% to 75% 6 to 7] to 2 [0 to 5], p <0.0001), while the decrease in the stdU group did not reach significance (from 6 [3 to 7] to 5 [2.75 to 6.75]). Within the first week of timer treatment children exhibited improvement, resulting in significantly fewer median wet days per week compared to the stdU group (3 [IQR 25% to 75% 1 to 6] vs 5 [3 to 7], p <0.05). This difference was even more pronounced at week 12 (table 2).

We compared voiding parameters between the 2 groups and found no significant differences regarding pretreatment MVV and AVV, or change scores for MVV, AVV, fluid intake or voiding frequency after treatment (table 3). When we assessed compliance we found that children in the timer group were more compliant, with only 10 being characterized as noncompliant compared to 19 in the stdU group (fig. 3,

Figure 2. Change in number of dry days per week for randomization groups as result of intervention. Children in timer group had significantly larger increase in dry days per week compared to children in stdU group (p<0.0001). Δ, differential.

Table 2. *Wet days per week before, during and after treatment*

	Median Wet Days (IQR 25%–75%)		
	stdU Group*	Timer Group†	p Value
Wk 0	6 (3–7)	7 (6–7)	<0.05
Wk 1	5 (3–7)	3 (1–6)	<0.05
Wk 12	5 (2.75–6.75)	2 (0–5)	<0.01

* Difference between weeks 0 and 12 was not significant.
† p <0.0001 between weeks 0 and 12.

Table 3. *Changes in MVV and AVV during randomization*

	stdU Group	Timer Group
Mean ± SD change in MVV/% expected bladder capacity	17.4 ± 26.6	17.2 ± 34.1
Mean ± SD change in AVV/% expected bladder capacity	9.8 ± 12.7	6.2 ± 9.3
Mean ± SD change in fluid intake (ml/day)	160 ± 342	109 ± 249
Mean ± SD change in fluid intake before 4:00 p.m. (ml)	160 ± 195	72 ± 189
Mean ± SD fluid intake wk 12 (ml/day)	940 ± 262	1,032 ± 267
Mean ± SD fluid intake before 4:00 p.m. wk 12 (ml)	584 ± 165	624 ± 225

Differences between treatment groups were not significant.

$p < 0.05$). Following the intervention period 27 children (90%) in the timer group reported a subjective effect of treatment, compared to only 7 (25%) in the stdU group ($p < 0.0001$). No child with enuresis in the timer group and only 1 in the stdU group achieved nighttime continence during the 12-week treatment period.

Response Predictors and Effect of Timer Assisted Urotherapy

The study was unable to document any difference between responders and nonresponders in the timer group with reference to gender distribution, former fecal problems, primary or secondary UI, body weight, height, age, gender, wet days per week, voiding frequency before intervention or fluid intake. No correlation between age and response to timer assisted urotherapy was seen. Furthermore, difference in compliance with the timed voiding regimen was not significant between children with (6 of 18 non-
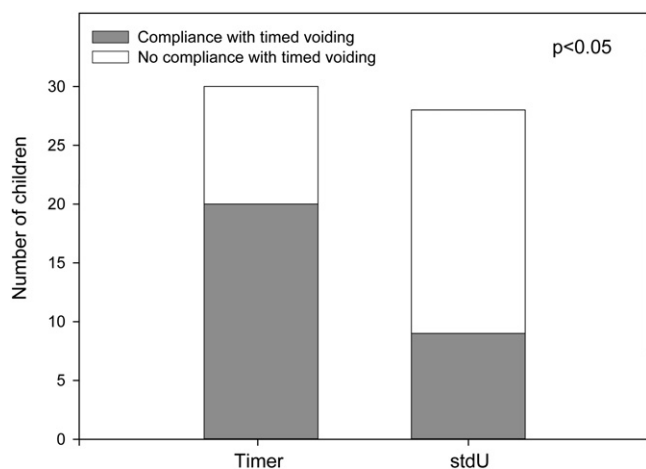
compliant) vs without (4 of 12) response to timer intervention.

MVV before treatment differed significantly between responders and nonresponders. Children not responding to timer assisted urotherapy had a lower pre-intervention bladder reservoir function compared to responders (mean ± SD 0.58 ± 0.19 vs 0.85 ± 0.37, $p < 0.05$). However, responders and nonresponders increased their MVV significantly during 12 weeks (mean ± SD 85% ± 37% vs 103% ± 60%, $p < 0.05$, and 55% ± 15% vs 85% ± 30%, $p < 0.01$, respectively), as illustrated in figure 4. Responders presented with significantly lower voiding frequency after intervention compared to nonresponders (mean ± SD 6.4 ± 1.7 vs 8.5 ± 1.7 voids daily, $p < 0.05$).

Of the 28 children initially randomized to standard urotherapy alone 26 agreed to continue training with a timer. Of these children 14 (54%) were full responders, 1 (4%) was a responder, 3 (12%) were partial responders and 7 (27%) exhibited no response.

Long-Term Effect

Of the 30 children in the timer group 27 were present at the first long-term followup visit (median 9.5 weeks after intervention, IQR 25% to 75% 3 to 26). All 9 children who became full responders on timer were still continent, while an additional 7 children had achieved full response. Six of these 16 children displaying full response were no longer dependent on the timer watch. Another 3 children were partial responders, implying that at this point
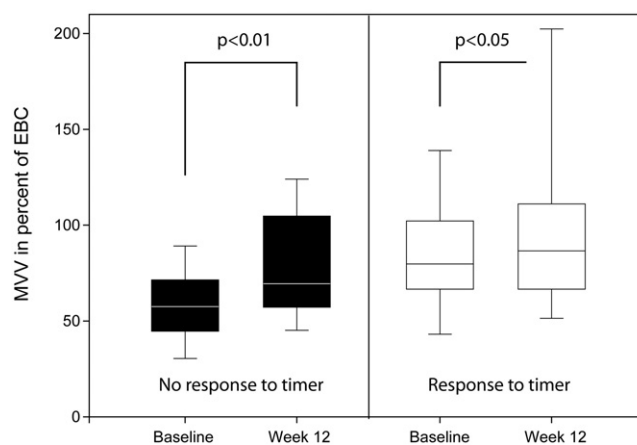

Figure 3. Compliance with timed voiding for children undergoing standard urotherapy alone vs timer assisted urotherapy. Significantly more children in timer group were compliant with timed voiding ($p < 0.05$).

Figure 4. Box plot of baseline and week 12 values of MVV for children undergoing timer assisted urotherapy during 12-week intervention grouped by response. Responders (open boxes) and nonresponders (filled boxes) achieved significant increase in MVV ($p < 0.05$ and $p < 0.01$, respectively). However, baseline MVV of nonresponders was significantly lower than corresponding MVV of responders to timer management ($p < 0.05$).

19 of 27 patients (70%) had obtained significant effect of the timer.

At the second followup (median 7 months after end of intervention, IQR 25% to 75% 6 to 19) none of the 9 children who initially achieved dryness experienced relapse. A total of 18 children (60%) in the timer group were completely daytime continent, 10 without using the timer.

DISCUSSION

This is the first randomized controlled study to our knowledge of the effect of a programmable timer watch as a supplement to standard urotherapy for the treatment of daytime incontinence in children with OAB. We found timer watch assisted urotherapy to be superior to standard urotherapy. The effect is prompt, being evident during the first week of training. The effect of the timer watch is still present when used in children refractory to 4 months of standard urotherapy, as more than two-thirds of these children responded when a timer was added. This response rate is similar to our preliminary observation that up to 70% of children responded to timer assisted urotherapy.[11]

Similar response rates were indicated in a comparative study of a contingent and a noncontingent alarm system in the treatment of daytime incontinence in children.[13] The success rates did not differ significantly between alarm systems and the noncontingent alarm, leading to continence in 59% of the children. However, the poor characterization of the participants and the lack of a randomized control group receiving standard urotherapy are significant limitations.

Compliance with the timed voiding regimen seemed to be the only parameter that differed significantly between the timer and stdU groups (fig. 3). Compliance is of utmost importance in urotherapy, a conclusion also suggested by previous studies.[2] In the present study the effect of the timer, which simply increases adherence to the voiding schedule, was dramatic. Our study clearly indicates that a programmable timer watch should be considered whenever a timed voiding regimen is initiated. It could be speculated that timer watch urotherapy should be reserved for children of a certain age. However, no correlation between age and response to timer assisted urotherapy was seen, indicating that this approach can be applied successfully in children starting at age 5 years.

Within the timer group children responding to treatment seemed to be characterized by a larger pretreatment MVV. All children increased the voided volume at a similar rate, and one could speculate that increasing the duration of the training period could have further improved MVV. Sureshkumar et al observed that increasing the duration of standard urotherapy from 6 to 9 months resulted in an improved response from 28% to 40%.[8] Our responders were also characterized by having significantly lower voiding frequency after intervention. This finding might simply be a result of an increased MVV but may also reflect a decrease in bladder overactivity. However, this issue was not clarified in this study, since urgency was not evaluated following treatment.

It is of particular interest to compare the results of the present study to previous reports on conservative management of daytime incontinence. The effect of standard urotherapy in this study is notably lower compared to other reports,[7–10] and compared to retrospective data from our center.[11] This difference can be explained by the fact that the participants in this study had severe daytime incontinence and 95% were refractory to standard urotherapy. Moreover, one should consider the differences in outcome measures in various studies that could contribute to the differences in response rates. Indeed, 90% of the children in the timer group in this study reported a subjective effect of the treatment, while only 60% had a significant response when evaluated by objective outcome measures.[4]

The observed response to timer assisted urotherapy in this study is of the same magnitude as the reported effect of anticholinergics.[14–16] While the pharmacological approach in treating daytime incontinence is associated with adverse effects,[17] timer assisted urotherapy is free of side effects and notably cheaper, and for these reasons seems particularly attractive. The documented effect of timer assisted standard urotherapy seems to reserve a place for this treatment modality above pharmacological intervention.

CONCLUSIONS

Timer watch assisted urotherapy seems far superior to standard urotherapy in the treatment of daytime incontinence in children with OAB. The effect appears to be a result of increased adherence to the timed voiding regimen. Reduced MVV may be a negative prognostic factor for timer treatment response or may necessitate a longer treatment course. The relapse rate after timer assisted urotherapy is low, and children seem to be able to dispense with the timer within months.

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EDITORIAL COMMENT

The authors provide some needed evidence regarding the therapeutic effect of urotherapy. We all believe that urotherapy is a useful first line treatment in urge incontinence (reference 3 in article).[1,2] However, far less is known regarding why it works. Is it the increased bladder awareness? Is it the modified fluid intake? Or is it just the fact that somebody cares? The present study teaches us that at least 1 factor is crucial—regular voiding. This finding, of course, does not disqualify the other parts of the urotherapeutic package, but it tells us that at least this element should be included. Maybe we should recommend that the timer watch be included from the start and not as a later add-on in resistant cases. An interesting incidental finding not commented on by the authors was that urotherapy, which is often recommended in enuresis as well, did not make the children dry at night.

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