

## The Trouble with Sleeping Can a Waterbed Help?

**Annie O'Connell**  
**Dr Chris Chapparo**  
University of Sydney, Australia

**Hugh Stewart**  
University of South Australia



Contact: Annie O'Connell :meigunyah@ozemail.com.au

### Abstract

Not all children with Autism Spectrum Disorder (ASD) present with sleep disturbance. However, when present, disturbed sleep can greatly impact on the daytime behaviour of children with ASD and their families' stress levels. Understanding sleep disturbance and possible interventions is crucial to knowing how to support families of children with ASD. Previously reported interventions have included changes in sleep routines, sleep environments, behaviour programs and medication.

This presentation will report on an exploratory study of five children (age 6-12 years) with ASD and sleep disturbance that participated in a trial of sleeping on a waterbed. Using a single system multiple baseline design repeated measures of sleep and daytime behaviours with and without a waterbed were used to determine the impact of sleeping on a waterbed. Results indicated positive changes in sleep patterns during the study. In presenting these findings, this paper will highlight the diversity of factors affecting sleep: the uniqueness of each child and family, types of sleep disturbances, maturational aspects of sleep, parental perspective and external influences. Families often adapted and changed their behaviour through using sleep diaries. Actimeters (movement monitors) gave objective sleep data that was useful in feedback to parents.

Sleep Disturbance requires serious consideration by professionals when supporting families with children with ASD. This presentation will overview the topic, give practical tips and parent feedback about factors that assisted their child's sleep patterns.

### Introduction

While Sleep Disturbance (SD) is not common to all children with ASD (including Asperger's Disorder) there is an increased prevalence in this group compared to the general population and children with other special needs (Patzold, Richdale, & Tonge, 1998; Richdale, 1999; Schreck & Mulick, 2000; Stores & Wiggs, 1998; Wiggs & Stores, 2000b). Sleep disturbance is linked with difficult daytime behaviours and compromised role performance at home and school in children (Chapparo & Ranka, 1997), and increased parental stress (Richdale, Gavidia-Payne, Francis, & Cotton, 2000; Wiggs &

Stores, 1996). Families coping with the special needs of a child with ASD are further stressed by sleep disturbed nights (Yates, 1996).

The cause of the SD has been linked to the behavioural and emotional factors. Studies suggest that children with ASD lack the ability to follow normal social cues thereby altering the resetting of the sleep/wake cycle (a circadian rhythm) on a daily basis leading to a SD in initiating and maintaining sleep (Richdale, 1999). In addition, SD has been linked to the underlying neural organisation subserving sleep, which appears dysregulated and delayed in the maturation of the sleep pattern in ASD, especially active (REM) sleep (Bergeron, Godbout, Mottron, & Stip, 1997; Diomedi et al., 1999; Elia et al., 2000; Tanguay, Ornitz, Forsythe, & Ritvo, 1976).

Literature predominantly supports behavioural approaches to intervention for sleep disturbance in children with ASD. (Schreck, 2001). Children with ASD often require extended sleep routines (Patzold et al., 1998; Schreck & Mulick, 2000) and changes to their environment (Glovak, 1995; Wiznitzer, 2000). Parental reports suggest that children's sleep pattern improved when sleeping on a waterbed. A waterbed provides physical warmth, tactile and proprioceptive contact with gentle/rhythmic movement. This type of sensory input is believed to lower arousal levels and is conducive to the state of rest (Richter & Oetter, 1990; Velluti, 1997). Although use of waterbeds has been shown to facilitate quiet sleep and organised behaviour in infants (Deiriggi & Miles, 1995; Korner, Lane, Berry, Rho, & Brown, 1990; White-Traut, 1995) and adults (Kline, Sullivan, & Coleman, 1974), there is no information that supports its use with children with ASD who have SD.

The purpose of this study was to explore the effect of a waterbed on sleep and daytime behaviours of a child with ASD and sleep and stress of parents. I wish to share with you how it extended my knowledge of the types of sleep disturbance within ASD, ways to study sleep, interventions for SD and the practical use of a waterbed.

## Methodology

A non-concurrent, single system multiple baseline design was used. The single system design is recommended for exploratory research such as this study (Law, Polatajko, Schaffer, Miller, & Macnab, 1991), has the least disruption to the families and allowed for the use of one waterbed. The children act as their own controls with their present sleep patterns and behaviours being recorded for two weeks as a baseline. This was followed by a trial of sleeping on the waterbed for eight weeks.

Participants volunteered for the study in response to mail outs from the Autism Association of South Australia Inc. Children had a positive diagnosis of Autism Spectrum Disorder or Asperger's Disorder and were between the ages of 5 –12 years. Their sleep disturbance was defined as exhibiting one or more of the following behaviours (mild, moderate or severe (Quine, 1991)):

- ◆ taking 60 minutes or more to settle and fall asleep with the parents being disturbed during this time
- ◆ waking during the night for more than a few minutes and disturbing the parents or going into the parents' room or bed
- ◆ waking before 5am

Instruments used to collect data included:

- ◆ A detailed sleep history from parents.
- ◆ A sleep diary completed morning and night (adapted from(Richdale & Prior, 1995)) describing the child’s sleep and daytime behaviours, parents’ stress and parents’ sleep.
- ◆ Actimeter (movement activated monitor) worn by the child on the same wrist or ankle each night. This provided objective data on sleep latency, total sleep time, sleep efficiency, sleep and wake bouts and fragmentation index (restlessness).

A pilot study on two children was completed to confirm the efficacy of instrumentation used prior to the start of the study.

## Results

Children and their families provided valuable but different information about sleep disturbance and intervention. Results included parents’ perceptions, changes in rates of SD and visual/statistical analysis. The data in both baseline and intervention was highly variable, therefore caution was used in analysis of results. All data series were tested for autocorrelations and data transformed if required. To determine significance of visual findings, all data series were analysed using the Proportion/Frequency approach based on Binomial Probability tables (Bloom, Fischer, & Orme, 1995) and three actimeter data series for each participant were tested on Randomization tests (Busk & Marascuilo, 2001; Edgington, 2001).

### EXTENDED TIME TRIAL

#### ALBERT and Family

Albert was a 7 year-old boy diagnosed with Asperger’s Disorder. His current SD was described as waking everynight (100%) and sometimes (36%) taking 60 minutes or more to settle to sleep with up to six parent interventions per night. On the 100mm visual analogue scale (no –severe problem) Albert’s current SD was rated at 50 with past SD at 100.

Albert’s parents reported he had greatly improved in his sleep pattern while sleeping on the waterbed. He was calmer and they had less disturbed nights. The rates of SD decreased during the trial as seen in Table 1.

	Initial Interview	Baseline	Trial
Waking at night	100%	92% (12/13 nights)	33% (8/24 nights)
Goes to parents bed	70%	69% (9/13 nights)	33% (8/24 nights)
Enuresis	50%	54%	50%
60 minutes or more to settle (actimeter)	36%	39% (5/13 nights)	25% (6/24 nights)
Parent intervention to settle to sleep		36%	16%

**Table 1 Albert’s Rates of Sleep Disturbance (% Nights)**

The actimeter data indicated a reduction in sleep latency means (-11 minutes) and increase in total sleep time means (+10 minutes) from baseline to trial as seen in Table 2.

	Baseline Mean & SD	Baseline Range	Trial Mean	Trial Range
Sleep Latency (minutes)	55 SD 32	11-119	44	6-96
Total Sleep Time (minutes)	589 SD 54	475-649	599	422-677

**Table 2 Albert's Actimeter Sleep Latency & Total Sleep Time (Means, Standard Deviation, Range)**

Visual and statistical analysis of the sleep diary indicated significant changes in morning, day and bed behaviours, reduced parental hassle and increased parental sleep. Actimeter data was significant in decreased Sleep Latency, Fragmentation Index (restlessness) and increased Sleep Efficiency.

Albert's parents found the sleep diary useful in seeing a pattern to his sleep. The actimeter graph was useful in providing feedback to parents and child about movement during sleep. The waterbed was motivating and reinforcing for Albert. He complied with wearing the actimeter as he wanted to sleep on the waterbed. He described the waterbed as his 'big hot water bottle'.

The outcome was that the parent did not purchase a waterbed. They felt Albert's sleep pattern had greatly improved and waited to see how he transferred back to his bed. They found it difficult to regularly change the sheets on the waterbed. At six months followup the improved sleep pattern was maintained in his own bed.

*LUCY and Family*

Lucy was a 6-year-old girl diagnosed with Asperger's Disorder. Lucy's current SD was reported as taking 60 minutes or more to settle, 3/4 times a week (50%) and waking during the night, 3 times a week (43 %). On the 100mm visual analogue scale (no – severe problem) Lucy's current SD was rated at 60 with past SD at 95.

Lucy's mother reported reduced SD from the beginning of the study and increased sleep time while on the waterbed. She was calmer with improved behavior reported at home and school. The rates of SD decreased during the trial as seen in Table 3.

	Initial Interview	Baseline	Trial
Waking at night	50%	17% (2/12 nights)	4% (1/23 nights)
60 minutes or more to settle (actimeter)	50%	30% (3/10 nights)	26% (5/19 nights)
Parent intervention to settle to sleep		81% (9/11 nights)	62% (15/24 nights)

**Table 3 Lucy's Rates of Sleep Disturbance (% Nights)**

The actimeter data indicated sleep latency similar in means and an increase in total sleep time means (+19 minutes) from baseline to trial as seen in Table 4.

	Baseline Mean & SD	Baseline Range	Trial Mean	Trial Range
Sleep Latency (minutes)	48 SD 41	17-150	44	1-111
Total Sleep Time (minutes)	612 SD 56	528-695	631	549-688

**Table 4 Lucy's Actimeter Sleep Latency & Total Sleep Time (Means, Standard Deviation, Range)**

Statistical analysis of the sleep diary indicated significant changes in morning and bed behaviour, reduced parental hassle and increased parental sleep. Actimeter data was significant in increased Sleep/Wake bouts and Fragmentation Index (restlessness).

The actimeter and sleep diary had been useful to shape sleep routines/patterns for Lucy and her family. Wearing the actimeter and sleeping on the waterbed were positive reinforcers for Lucy. A dummy actimeter was used for alternate weeks when data not collected, as Lucy became anxious about not wearing the actimeter. The waterbed was seen as comfortable, inducing rest and relaxation with Lucy reported to be often 'curled up like a cat' during the day or night. While Lucy had less sleep disturbance and increased sleep time while sleeping on a waterbed, she also had increased movement (bouts and restlessness).

The outcome was that the parents did not purchase a waterbed. They felt Lucy had a better sleep pattern and waited to see how she transferred back to her bed. At six months followup, the sleep pattern had been maintained.

GUS and Family

Gus was a 7 year- old boy with High Functioning Autism. Gus's current SD was described as waking before 5 am, staying in his bed and gradually become louder while talking and singing to himself, up to 7/ week (<=100%). During the study he had Melatonin to assist settling to sleep. On the 100mm visual analogue scale (no –severe problem) Gus's current sleep disturbance was rated at 60 with the past SD at 34.

Parents' reported that Gus was more settled, calmer during the day and more restless at night while sleeping on waterbed. The rates of SD decreased during the trial as seen in Table 5.

	Initial Interview	Baseline	Trial
Sleep Diary: Waking </= 5am	<=100%	43% (9/21 mornings)	5% (1/20 mornings)
Actimeter: Waking </= 5am		43% (6/14 mornings)	15% (3/20 mornings).
Waking after 6pm Actimeter & Sleep Diary		0%	25% (5/20 mornings)

**Table 5 Gus's Rates of Sleep Disturbance (%Nights)**

The actimeter data indicated the same sleep latency means and an increase in total sleep time means (+19 minutes) from baseline to trial as seen in Table 6.

	Baseline Mean & SD	Baseline Range	Trial Mean	Trial Range
Sleep Latency (minutes)	19 SD 11	4-46	19	5-45
Total Sleep Time (minutes)	557 SD 36	494-600	576	550-601

**Table 6 Gus's Actimeter Sleep Latency & Total Sleep Time (Means, Standard Deviation, Range)**

Statistical analysis of the sleep diary indicated significant changes in morning, day and bed behaviours and increased parental sleep. Actimeter data was significant in increased Fragmentation Index (restlessness).

The baseline was extended as Gus initially held himself perfectly still when wearing the actimeter and needed to be encouraged to shake his arm when he put the actimeter on and off. Gus wanted to sleep on the top bunk bed and his parents were initially concerned that he wouldn't adapt to the waterbed. A new 'Pokemon' quilt reinforced the move. The parents found the sleep diary useful in understanding his early wakings especially when anxious eg trial with a new teacher or excited eg sports day. They appeared to be more accepting of the variations in his sleep patterns. His mother reported increased sleep linked with less stress and better coping skills particularly on the mornings were she slept beyond 6 am. The parents' reported the waterbed to be comforting for all the children when unwell.

The outcome was that all siblings now sleep on waterbeds. Six months followup indicated that Gus's sleep pattern could still vary but with less early mornings. He was settling to sleep without Melatonin for longer periods and they were monitoring its use.

### Discussion

- ◆ Children with ASD presented with a spectrum of SD in difficulty settling, night waking, enuresis, early rising and 'contented sleeplessness'(Wiggs & Stores, 2000a).
- ◆ All the children (pilot and extended trial) presented with ongoing SD. There were differences in some children between initial reported and baseline rates of SD perhaps due to child's maturation or parent sensitivity to SD (Hering, Epstein, Elroy, Iancu, & Zelnik, 1999). Four out of five families reported improvements in SD while on the waterbed. All the children adapted easily to the waterbed and recorded increased total sleep time. All children still varied greatly in sleep patterns. By the definition of this study, they all still presented with a SD although reduced in severity.
- ◆ Sleep diaries were useful as an assessment and monitoring tool: quick, easy to complete, increases awareness of child's sleep patterns. They highlighted other factors impacting on sleep including: child's arousal level, anxieties, illness, medication; changes in routines, holidays, day light saving, bedroom arrangements; day sleeps; illness/health of family and effect of parents' work.

- ◆ Actimeters were useful in providing feedback to the parents eg comparing rates of SD and the variability of their child's sleep patterns over a week. Children with ASD tolerated wearing the actimeter except for two children not included in the study (Hering et al., 1999; Wiggs & Stores, 2000a). The impact of the waterbed's movement on the actimeter is not known (Sadeh, Hauri, Kripke, & Lavie, 1995).
- ◆ During the extended time trial there was a reduction in the rate of SD, improvements in child's behaviours, decrease in parental hassle and increase in parental sleep. Six to eight weeks was needed to gain a change in the sleep pattern. The actimeter, waterbed and parents' focus on the sleep diary appeared to facilitate/reinforce/cue a positive sleep pattern. At followup all children reported to have maintained their improved sleep pattern and only one child continues sleeping on a waterbed.
- ◆ A waterbed appears conducive to the state of rest and relaxation. Parents provided useful practical feedback about waterbeds. Further consideration is needed regarding the effect of the waterbed on a child's movement and temperature (Bader & Engal, 2000) during sleep.

### Conclusion

The severity of sleep disturbance in children with ASD was reduced after sleeping on a waterbed for eight weeks. The use of a sleep diary recorded by the parents and the wearing of an actimeter by the child facilitated a positive sleep pattern and provided valuable insights into the factors affecting sleep. Families of children with ongoing sleep disturbance may need support and feedback to achieve an improved sleep pattern over 2-3 months. A waterbed appears conducive to the state of rest and relaxation with children who have ASD and SD. Some children appeared to find the waterbed motivating/reinforcing in establishing a positive sleep pattern.

### Acknowledgments

Special thanks to staff of the Centre for Sleep Research, University of South Australia, for their support and the loan of the actimeters, monitors and software. Mr Waterbed, South Australia kindly donated the replacement water heater and provided regular use of a waterpump.

### References

- Bader, G. G., & Engal, S. (2000). The influence of bed firmness on sleep quality. *Applied Ergonomics*, 31(5), 487- 497.
- Bergeron, C., Godbout, R., Mottron, L., & Stip, E. (1997). Sleep and dreaming in Asperger's Syndrome. *Sleep Research*, 26, 541.
- Bloom, M., Fischer, J., & Orme, J. G. (1995). *Evaluating Practice: Guidelines for the Accountable Professional* ( 2nd ed.). Boston: Allyn and Bacon.
- Busk, P. L., & Marascuilo, L. A. (2001). Statistical Analysis in Single-Case Research: Issues, Procedures, and Recommendations, with Applications to Multiple Behaviors. In T. R. Kratochwill & J. R. Levin (Eds.), *Single-Case Research Design and Analysis* (pp. 160-185). Madison: Lawrence Erlbaum Associates Publishers.
- Deiriggi, P. M., & Miles, K. E. (1995). The Effects of Waterbeds on Heart Rate in Preterm Infants. *Scholarly Inquiry of Nursing Practice*, 9(3), 245-258.
- Diomedi, M., Curatolo, P., Scalise, A., Placidi, F., Caretto, F., & Gigli, G. L. (1999). Sleep abnormalities in mentally retarded autistic subjects: Down's syndrome with mental retardation and normal subjects. *Brain & Development*, 21(8), 548-553.

- Edgington, E. S. (2001). Nonparametric Tests for Single-Case Experiments. In T. R. Kratochwill & J. R. Levin (Eds.), *Single-Case Research Design and Analysis*. Madison: Lawrence Erlbaum Associates.
- Elia, M., Ferri, R., Musumeci, S. A., Del Gracco, S., Bottitta, M., Scuderi, C., Miano, G., Panerai, S., Bertrand, T., & Grubar, J.-C. (2000). Sleep in subjects with autistic disorders: a neurophysiological and psychological study. *Brain and Development*, 22(2), 88-92.
- Glovak, S. (1995). Parents find relief from sleep problems through experimentation. *Sensory Integration Quarterly*(Summer), 13.
- Hering, E., Epstein, R., Elroy, S., Iancu, D. R., & Zelnik, N. (1999). Sleep patterns in autistic children. *Journal of Autism & Developmental Disorders*, 29(2), 143-147.
- Kline, M. V., Sullivan, P. A., & Coleman, L. L. (1974). Some clinical sleep parameters with the Innerspace flotation bed: A preliminary report with reference to insomnia. *Journal of the American Society of Psychosomatic Dentistry and Medicine*, 21(1), 3-9.
- Korner, A. F., Lane, N. M., Berry, K. L., Rho, J. M., & Brown, B. W. (1990). Sleep enhanced and irritability reduced in preterm infants: differential efficacy of three types of waterbeds. *Journal of Developmental and Behavioural Pediatrics*, 11(5), 240-246.
- Law, M., Polatajko, H. J., Schaffer, R., Miller, J., & Macnab, J. (1991). The impact of heterogeneity in a clinical trial: Motor outcomes after Sensory Integrative Therapy. *Occupational Therapy Journal of Research*, 11(3), 177-189.
- Patzold, L. M., Richdale, A. L., & Tonge, B. J. (1998). An investigation into sleep characteristics of children with autism and Asperger's Disorder. *Journal of Paediatrics and Child Health*, 34(6), 528-533.
- Quine, L. (1991). Sleep problems in Children with mental handicap. *Journal of Mental Deficiency Research*, 35, 269-290.
- Richdale, A., Gavidia-Payne, S., Francis, A., & Cotton, S. (2000). Stress, Behaviour and Sleep problems in Children with an Intellectual disability. *Journal of Intellectual and Developmental Disability*, in press.
- Richdale, A. L. (1999). Sleep problems in autism: prevalence, cause, and intervention. *Developmental Medicine & Child Neurology. Developmental Medicine and Child Neurology*, 41(1), 60-66.
- Richdale, A. L., & Prior, M. R. (1995). The sleep/wake rhythm in children with autism. *European Child and Adolescent Psychiatry*, 4(3), 175-186.
- Richter, E., & Oetter, P. (1990). Environmental Matrices for Sensory Integrative Treatment. In S. C. Merrill (Ed.), *Environment implications for Occupational Therapy practice*. Rockville, MD, USA: The American Occupational Therapy Association.
- Sadeh, A., Hauri, P. J., Kripke, D. F., & Lavie, P. (1995). The Role of Actigraphy in the Evaluation of Sleep Disorders. *Sleep*, 18(4), 288-302.
- Schreck, K. A. (2001). Behavioral treatments for sleep problems in autism: Empirically supported or just universally accepted. *Behavioral Interventions*, 16(4), 265-278.
- Schreck, K. A., & Mulick, J. A. (2000). Parental Report of Sleep Problems in Children with Autism. *Journal of Autism and Developmental Disorders*, 30(2), 127-135.
- Stores, G., & Wiggs, L. (1998). Abnormal sleep patterns associated with autism. *autism*, 2(2), 157-159.
- Tanguay, P., Ornitz, E. M., Forsythe, A. B., & Ritvo, E. R. (1976). Rapid eye movement (REM) activity in normal and autistic children during REM sleep. *Journal of Autism and Childhood Schizophrenia*, 6(3), 275-288.
- Velluti, R. a. (1997). Interactions between sleep and sensory physiology. *Journal of Sleep Research*, 6, 61-77.
- White-Traut, R. C. (1995). Response to "Effects of Waterbeds on Heart Rate in Preterm Infants". *Scholarly Inquiry of Nursing Practice*, 9(3), 259-262.
- Wiggs, L., & Stores, G. (1996). Severe sleep disturbance and daytime challenging behaviour in children with severe learning disabilities. *Journal of Intellectual Disabilities Research*, 40(6), 518-528.
- Wiggs, L., & Stores, G. (2000a). Actigraphic Data of Children and Adolescents with Autistic Spectrum Disorders. *Journal of Sleep Research*, 9(Supplement 1), 209.



- Wiggs, L., & Stores, G. (2000b). Sleep disorders in Children and Adolescents with Autistic Spectrum Disorders. *Journal of Sleep Research*, 9(Supplement 1), 209.
- Wiznitzer, M. (2000, May-June). Unpacking your bags: Sleep strategies for individuals with autism. *Autism & Asperger's Digest*, May-June, 23-25.
- Yates, J. (1996, Nov-Dec). Stress and Parenting a Child with Autism. *Advocate*, 20.