

## CASE REPORT

Leonid Kayumov,<sup>1,2</sup> Ph.D.; S. R. Pandi-Perumal,<sup>1</sup> M.Sc.; Paul Fedoroff,<sup>3</sup> M.D.; and Colin M. Shapiro,<sup>1</sup> Ph.D.

# Diagnostic Values of Polysomnography in Forensic Medicine

**REFERENCE:** Kayumov L, Pandi-Perumal SR, Fedoroff P, Shapiro CM. Diagnostic values of polysomnography in forensic medicine. *J Forensic Sci* 2000;45(1):191–194.

**ABSTRACT:** A man accused of a first-degree murder of a two-year-old girl claimed that he had not been conscious during the time of the alleged murder. The possibility that he may have committed the crime while “sleepwalking” was raised. The forensic psychiatrist looked to the sleep disorders facility to conduct polysomnographic investigation of the accused in order to investigate the possibility that he had a parasomnia. Overnight sleep recordings with video surveillance carried out for two consecutive nights showed no evidence of parasomnia. On the basis of the full assessment, the final report of the forensic psychiatrist did not support a legal defense of non-insane automatism and “sleepwalking” was withdrawn as a possible defense by the lawyer of the accused.

**KEYWORDS:** forensic science, polysomnography, non-insane automatism, sleepwalking, parasomnia

Although the overall prevalence of sleep-related violent behavior is unknown, it has been well-documented in several case reports (1–3). Recently Ohayon et al. (4) published the results of the first epidemiological study of violent or injurious behaviors occurring in sleep in the general population. Of the 4972 subjects in their study, 2.1% exhibited such behavior while asleep and were mostly males. Polysomnography (PSG), in association with a positive familial history and detailed clinical assessment, plays a prominent role in establishing the diagnosis of parasomnia. This complex set of clinical entities (somnambulism, night terrors, REM behavior disorder) characterized by automatic, stereotypic and amnesic behavior can result in self-injury and can pose a threat to others. Cases of sleep-related violence, considered within the framework of contemporary jurisprudence as “non-insane automatism” (5), have been challenged in the courts with either acquittal (1,6) or conviction (7), depending on evidential circumstances.

There are few PSG-documented cases of parasomnia-related crimes available through medline literature search (1,7,8). We now report an interesting case of a man accused of a first-degree murder of a two-year-old girl.

### Case Presentation

Mr. T.Q. is a 26-year-old unemployed, married young man who was initially referred by his defense lawyer to a forensic psychiatrist (PF). The accused claimed to have no memory of the alleged events in question; he was remanded by the Crown (prosecution) to a secure forensic psychiatric facility for a full evaluation, including two overnight sleep studies.

### Events in Question

Mr. T.Q. explained that the deceased victim was the daughter (by another man) of his girlfriend (of four months). He had agreed to care for her when his pregnant partner went into labor. He was able to recall in detail the events of the two days he cared for her in his apartment prior to the night in question. On that night, he remembered bringing her home, giving her supper, and putting her to bed. He remembered playing an interactive computer game on the internet, drinking an unspecified amount of alcohol, and then falling asleep on the couch. At approximately 1:00 a.m., he said he awoke and on checking on the victim, noticed that she did not seem to be breathing. When he investigated, he saw that she was covered in blood and was not breathing. He panicked and called the emergency service (dialed 911). Next, he called a friend in the apartment. He insisted that he had no recollection of what had happened from the time he fell asleep to the time he noticed the victim was not breathing. Although he accepted the circumstances suggested that he was the murderer, he maintained that he had not been conscious during the time of the alleged murder. The possibility that Mr. T.Q. may have committed the crime while “sleepwalking” was raised.

### Relevant Past History

Mr. T.Q. had no family history of psychiatric, criminal, drug or alcohol abuse. His father was a prominent scientist at a large teaching hospital. Mr. T.Q. was adopted at the age of six months. He had no history of emotional, physical or sexual abuse as a child. He had completed grade ten, having failed grades three and

<sup>1</sup> Department of Psychiatry and Sleep Research Laboratory, The Toronto Hospital, Western Division, Toronto, Canada.

<sup>2</sup> Playfair Neuroscience Unit, The Toronto Hospital Research Institute, Toronto, Canada.

<sup>3</sup> Centre for Addiction and Mental Health, University of Toronto, Toronto, Canada.

Received 1 Feb. 1999; and in revised form 13 Apr. 1999; accepted 20 Apr. 1999.

seven. He had never been suspended or expelled from the school. The longest job Mr. T.Q. had ever held was for two months selling newspapers. He had been married at age 21 to a 23-year-old woman. The marriage was troubled and he had been separated for three years prior to the events in question. Mr. T.Q. had no children of his own. He denied any problems with alcohol or drug abuse. He had no previous history of criminal convictions. He had no known medical problems and was on no medications. Specifically, there was no history of head trauma, loss of consciousness or fugue states. He had no focal neurologic signs. He had no previous history of psychiatric treatment.

Mr. T.Q.'s sexual history was within normal limits. He identified himself as heterosexual and denied any paraphilic fantasies or behaviors. He specifically denied any pedophilic or sadistic sexual interest or behaviors.

On mental status examination, aside from a feeling of "chronic depression" which had worsened since Mr. T.Q.'s arrest, there were no abnormalities. Specifically, there were no delusions or hallucinations detected.

The forensic psychiatrist looked to the sleep disorders facility (CS) to conduct polysomnographic investigation of Mr. T.Q. in order to investigate the possibility that he had a parasomnia.

#### *Polysomnographic Findings*

Two consecutive overnight sleep studies were carried out at a secure forensic psychiatric ward using a portable computerized acquisition system (Alice-3) with video surveillance. A standard PSG montage (10–20 system) included electroencephalographic, electromyographic and electro-oculographic monitoring. Respiration (oxygen saturation and number of respiratory events) and periodic leg movements (PLMs) were also recorded. The overnight PSG recordings were scored according to standardized criteria (9). The sleep researchers (LK; PSR) who conducted, scored and reported the sleep studies were blind with respect to the circumstances of the case.

Mr. T.Q. reported awakening at 7:30 a.m. on the day of the study and he had not taken any naps subsequently. Although he did not use any medications for the past two weeks, he had undergone a sodium amytal test one day before the first sleep study. He had consumed one cup of coffee and one cup of tea prior to noon. During the study setup time Mr. T.Q. looked calm and friendly. He retired at 00:03. His sleep onset latency was 17.5 min (normal). He slept for 321.5 min (5.3 h), plus 62 min of intervening wakefulness, giving a sleep efficiency of 83.8% (slightly decreased). He had REM onset latency of 143.5 min (delayed). His sleep architecture was as follows: 9.3% stage 1 (increased); 39.9% stage 2 (slightly decreased); 5.7% stage 3 (slightly decreased); 8.3% stage 4 (decreased); 20.6% REM sleep (decreased); 0.6% movement time; 16.2% wake (increased).

Throughout the night, Mr. T.Q. had 11 respiratory events (2.0/h) during his sleep: 1 central apnea, 3 obstructive apneas and 7 hypopneas. His oxygen saturation was maintained in the range of 96 to 100% during 66% of the sleep time and in the range of 91 to 95% during 34% of the sleep time. These respiratory measures are within normal limits. A total of 68 spontaneous arousals were recorded (12.8/h). There were five arousals from deep sleep (see Fig. 1). However, all of the arousals were related to Mr. T.Q.'s loud snorts. The snorts woke him up on every occasion. This was evident from the video recording and also witnessed by the sleep researchers conducting the sleep study. Arousals were not accompanied by a change in respiration and heart rate. Most of the night Mr.

T.Q. slept soundly in a supine position without much movement. Loud snoring was heard throughout the night. There was one leg movement during his sleep.

On the following day Mr. T.Q. had not taken any medications. He underwent a forensic hypnotic interview for 1.5 h. He had consumed one cup of coffee and one cup of tea prior to noon. Before retiring at 10:42 p.m. he complained of slight restlessness and chest pain. His sleep onset latency was 6.5 min (normal). He slept for 387 min (6.4 h), plus 51.5 min of intervening wakefulness, giving a sleep efficiency of 83.0% (slightly decreased). He had REM onset latency of 124 min (delayed). His sleep architecture was as follows: 5.2% stage 1 (slightly increased); 39.7% stage 2 (decreased); 6.8% stage 3 (normal); 16% stage 4 (slightly increased); 20.5% REM sleep (decreased); 0.3% movement time; 11.5% wake (increased).

Mr. T.Q. had 11 respiratory events (1.7/h) during his sleep: 2 central apneas, 2 obstructive apneas and 7 hypopneas. His oxygen saturation was maintained in the range of 96 to 100% during 88% of the sleep time, in the range of 91 to 95% during 11% of the sleep time and in the range of 86 to 90% during 1% of the time. A total of 90 spontaneous arousals were recorded (14/h—raised). Six of the arousals were from deep sleep and accompanied by loud snorts (arousals from deep sleep are considered to be characteristic of parasomnia). Loud snoring was heard throughout the night. There were three leg movements during his sleep (0.4/h).

On the basis of the full assessment, the final report of the forensic psychiatrist did not support a legal defense of non-insane automatism and "sleepwalking" was withdrawn as a possible defense by Mr. T.Q.'s lawyer.

#### **Discussion**

Parasomnias consist of heterogeneous groups of sleep behavior disorders with diverse etiologies and different symptomatologies that includes disorders of arousal, partial arousal and sleep stage transition. Somnambulism (sleepwalking) as an arousal parasomniac disorder is of particular interest in the context of this study since this may involve the complex sequences of motor activity with potential physical harm. Rarely, homicide or suicide during an episode of somnambulistic behavior has been reported (10). Somnambulism is seen as "central nervous system immaturities" in children, but is considered to be more psychopathological in adults (11).

Several studies have demonstrated a strong familial pattern of somnambulism. The incidence of the disorder is 60% when both parents are affected. A relevant family and medical history are the most important primary factors in establishing the clinical diagnosis of parasomnia. Since Mr. T.Q. was adopted at the age of 6 months, family history of somnambulism is not available. On the other hand, polysomnography and the simultaneous video recording are useful diagnostic tools that can reveal behavioral abnormalities and electrophysiological changes during different sleep stages objectively supporting the initial diagnosis. Although somnambulistic episodes occur almost exclusively in NREM sleep stage 3 and 4 (slow wave sleep), cases of unusual and often violent behavior related to dream enactment have been reported in REM behavior disorder (12). In NREM parasomnias all night polysomnography recording traces frequently display EEG slow waves with high amplitude just before the onset of movement. Abrupt arousals from slow wave sleep followed by rapid reentry to the deep sleep are the most characteristic polysomnographic features of arousal disorders. This slow wave activity is different from the immediately preceding deep sleep pattern by its hypersynchronicity which persists even after the parasomnia event has be-

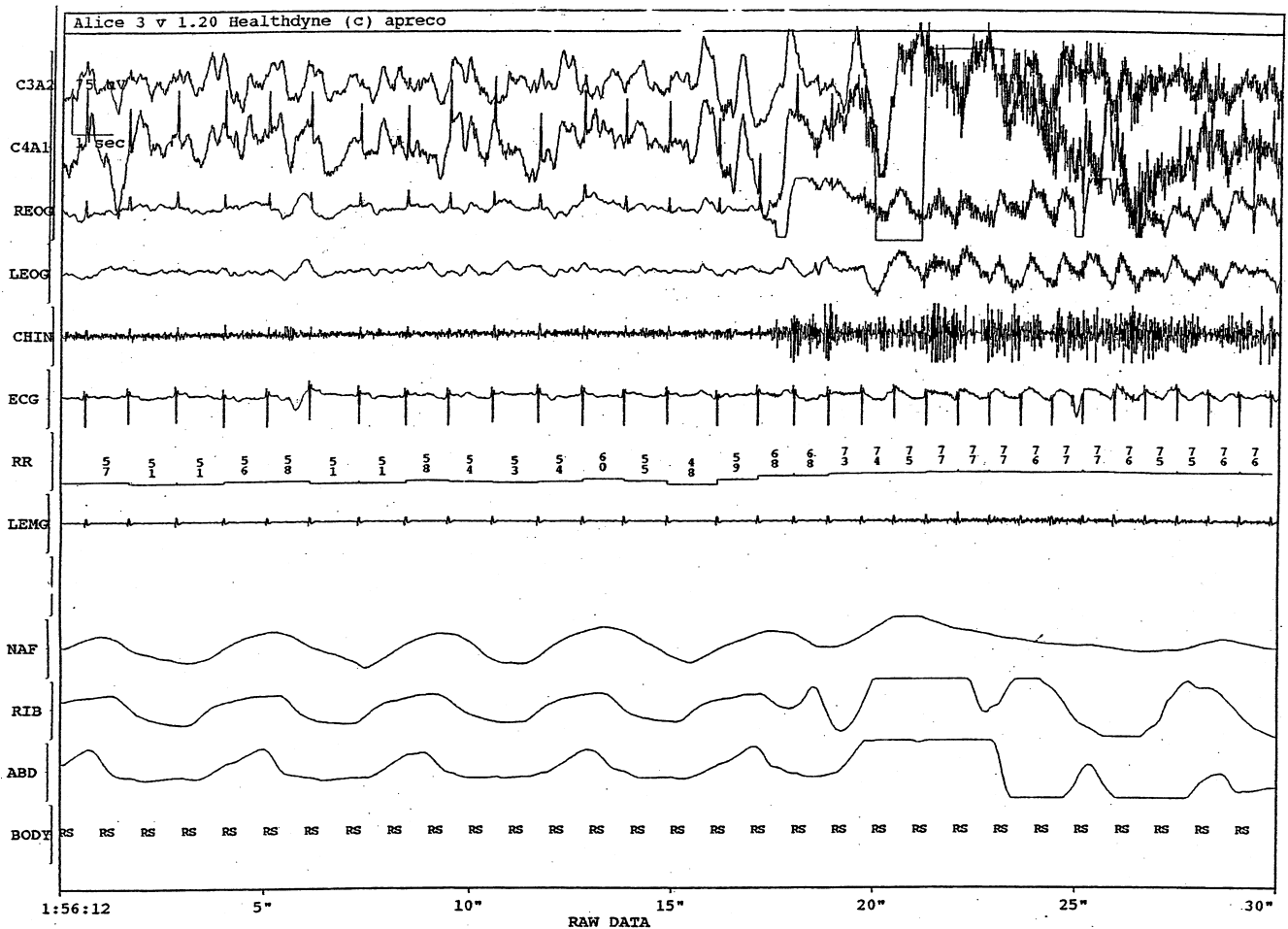


FIG. 1—An arousal from deep sleep. The example is from Mr. T.Q.'s first nocturnal polysomnographic study: C3-A2 and C4-A1—2 electroencephalographic channels; REOG and LEOG—2 electrooculographic channels; chin—1 chin electromyographic channel; ECG—1 electrocardiographic channel; LEMG—1 leg electromyographic channel; NAF, RIB and ABD—3 respiratory channels.

gun and the subject is moving (13). These endogenously generated arousals are accompanied by profound autonomic response (10).

Mr. T.Q.'s overnight sleep recordings, carried out for two consecutive nights, showed several abrupt arousals from deep sleep. However, careful visual and video monitoring revealed that these arousals were caused by an exogenous factor, namely by the subject's loud snorts. We are inclined to think that these snorts, hypopneas with crescendo snoring and episodes of oxygen desaturation during Mr. T.Q.'s sleep probably were related to sodium amytal tests performed prior to the first overnight sleep study. The arousals were not accompanied by prominent changes in respiratory and heart rate. Moreover, the arousals experienced by Mr. T.Q. during deep sleep were not followed by the slow wave sleep pattern. The arousals resulted in changing of sleep pattern towards more superficial sleep. Thus, we concluded that the study does not support a diagnosis of parasomnia.

One-and-half years later the authors learned that Mr. T.Q. had been tried and found guilty in a jury trial of first-degree murder and was subsequently sentenced to life imprisonment. This case presented clinical and ethical dilemmas emerging from the forensic application flowing from the proliferation of research activity in sleep medicine since the initial discovery of REM and NREM sleep in the 1950's (14). We believe this case report is valuable in the same way that negative results of scientific studies are valuable. It

is more likely for a case to be published in which the sleep study showed a specific pathology and led to an acquittal. This case illustrates a negative finding that should be reassuring to those who think that special investigation would always provide positive information for defense.

## References

1. Broughton R, Billings R, Cartwright R, Doucette D, Edmeads J, Edward M, et al. Homicidal somnambulism: a case report. *Sleep* 1994; 17:253-64.
2. Tison F, Wenning GK, Quinn NP, Smith SMJ. REM sleep behaviour disorder as the presenting symptom of multiple system atrophy (letter). *J Neurol Neurosurg Psychiatry* 1995;58:379-80.
3. Uchiyama M, Isse K, Tanaka K. Incidental Lewy body disease in a patient with REM sleep behavior disorder. *Neurology* 1995;45:709-12.
4. Ohayon M, Caulet M, Priest R. Violent behavior during sleep. *J Clin Psychiatry* 1997;58:369-78.
5. Schiffer ME. *Mental disorder and the criminal trial process*. Toronto: Butterworth and Company, 1978.
6. Oswald I, Evans J. On serious violence during sleep-walking. *Br J Psychiatry* 1985;147:688-91.
7. Moldofsky H, Gilbert R, Lue FA, McLean AW. Sleep related violence. *Sleep* 1995;18:731-9.
8. Schenck CH, Mahowald MW. A polysomnographically documented case of adult somnambulism with long-distance automobile driving and frequent nocturnal violence: parasomnia with continuing danger as a nonsane automatism. *Sleep* 1995;18:765-72.

9. Rechtschaffen A, Kales A, editors. A manual of standardized terminology techniques and scoring system for sleep stages of human subjects. No. 204. Washington, DC: National Institutes of Health, 1968.
10. Diagnostic Classification Steering Committee, Thorpy MJ, Chairman. International classification of sleep disorders: diagnostic and coding manual. Rochester, MN: American Sleep Disorders Association, 1997.
11. Williams RL, Karacan I, Moore CA, editors. Sleep disorders: diagnosis and treatment. Toronto: Wiley-Interscience, 1988.
12. Mahowald MW, Schenck CH. REM sleep behavior disorder In: Kryger MH, Roth T, Dement WC, editors. Principles and practice of sleep medicine. Philadelphia: WB Saunders, 1994;574–88.
13. Keefauver SP, Guilleminault C. Sleep terrors and sleep walking. In: Kryger MH, Roth T, Dement WC, editors. Principles and practice of sleep medicine. Philadelphia: WB Saunders, 1994;567–73.
14. Guilleminault C, Leger D, Philip P, Ohayon MM. Nocturnal wandering and violence: review of sleep clinic population. *J Forensic Sci* 1998; 43:158–63.

Additional information and reprint requests:

Dr. Leonid Kayumov  
Department of Psychiatry  
University of Toronto and Toronto Hospital  
Western Division  
MP 10–320, 399 Bathurst St., Toronto, ON, M5T 2S8, Canada