I. Regional cerebral blood flow evidence. *Archives of General Psychiatry*, **43**, 114–124.

WILCOX, J. A. & NASRALLAH, H. A. (1987) Childhood head trauma and psychosis. *Psychiatry Research*, **21**, 303–306.

Eadbhard O'Callaghan, MRCPsych, *Registrar in Psychiatry*; Conall Larkin, MRCPsych, FRCP(C), *Consultant Psychiatrist, Cluain Mhuire Family Centre, Blackrock, County Dublin*; Oonagh Redmond, MSc, *Biophysicist*; John Stack, MRCPI, FFR(RCSI), *Lecturer in Diagnostic Radiology*; Joseph T. Ennis, MD, FRCPI, FRCR, *Director, Institute of Radiological Sciences, Mater Hospital, Dublin*; *John L. Waddington, MA, MSc, PhD, *Senior Lecturer in Clinical Pharmacology, Royal College of Surgeons in Ireland, Dublin*

*Correspondence: *Royal College of Surgeons in Ireland, St Stephen's Green, Dublin 2, Ireland*

British Journal of Psychiatry (1988), **153**, 396–399

Effects of Thallium Poisoning on Intellectual Function

A student of chemistry was treated for thallium poisoning. Seven months after his ingestion of thallium, intelligence tests were performed on the patient and his non-identical twin brother, who was of similar educational background. These indicated severe deterioration in intellectual function of the patient, particularly in memory and performance abilities. Tests 13 months after ingestion showed little general improvement.

Little is known of the deleterious effects of heavy metals such as thallium upon mental function. There have been periodic outbreaks of thallium poisoning, usually due to the consumption of contaminated grain, but occasionally due to criminal poisoning. Ginsburg & Nixon (1932) and Reed *et al* (1963) reported on separate outbreaks in the USA which were due to pesticide ingestion. Involvement of the CNS occurs within days, presenting with ataxia and paraesthesiae, and including retrobulbar neuritis, tremor, chorea, athetosis and myoclonus. There is often pronounced impairment of consciousness, paranoia and depression (Grinker & Sahs, 1966). There may be cranial nerve palsies, delirium, hallucinations, coma and fits, progressing to respiratory paralysis. Alopecia occurs after several days, and toxic damage can occur to the kidneys.

Follow-up studies are limited to that by Reed *et al* (1963), in which sequelae were found only in the nervous system. These were ataxia, tremor, abnormal movements, fits and visual disturbances. There was no mention of persisting intellectual disturbance, and, indeed, a reading of the literature suggests that this complication has rarely been noticed. However, no studies have used detailed psychometric tests upon cases of severe poisoning. We report here one such case demonstrating that thallium may cause severe deterioration in intellectual function, particularly in memory and performance abilities.

Case report

History

The patient was a 20-year-old student of chemistry who was admitted after collapsing in the early hours of the morning while passing water. He complained of tingling in the fingers and lips.

On examination he was alert, oriented and co-operative. There was slight loss of pin-prick sensation in both hands and over the forehead. The rest of the examination was normal. Blood pressure was 120/60 lying and standing, and pulse rate was 60 per minute.

He was concerned that he had been working with thallium in the laboratory at college, although the safety precautions appeared to have been satisfactory. Nevertheless, samples of blood and urine were sent to Guy's Poisons Unit for analysis. These showed a serum thallium level of 5750 μg/l and a urine concentration of 60 000 μg/l. A value in excess of 200 μg/l for either sample would be considered toxic.

https://doi.org/10.1192/bjp.153.3.396 Published online by Cambridge University Press

He was admitted and treated with the chelating agent Prussian blue (potassium ferricyanoferrate). In the first day he complained of increasing pain in the legs, with paraesthesiae and weakness, and had objective loss of power in the feet and the toes. It was also difficult for him to swallow, and an intravenous infusion was commenced. He continued to deteriorate, with increasing weakness and reduced vital capacity. An epidural was required to control the pain in the legs and he was admitted to intensive care.

Diethyldithiocarbonate 0.75 mg was given but the patient became stuporose within three hours and it was discontinued. It was later shown that the serum thallium level rose from 800 μg/l to 1350 μg/l during this period. His level of consciousness began to improve but then, over the next few days, deteriorated, although he remained rousable at all times. Haemodialysis was commenced. A psychiatric examination at that time was met with absolute denial that the thallium had been ingested with suicidal intent, and the patient pointed out that, had he wished to take his life, he knew of several less painful ways to do so. No evidence was found of any other abnormal beliefs which might have accounted for purposeful ingestion of thallium. Apart from the impairment of level of consciousness no abnormalities were found on mental state examination. It was estimated that about 3 g of thallium had been ingested.

Six days after admission, further chelation was attempted with dithiocarbonate during haemodialysis, and there was again a sudden deterioration in level of consciousness and respiratory function, requiring ventilation. During this time the serum thallium rose from 390 μg/l to 460 μg/l and in the dialysate it rose from 63 mg/l to 81 mg/l. His level of consciousness then improved rapidly but he continued to require ventilation.

Eleven days after admission he had begun to breathe again and the thallium level was 250 μg/l. An electromyograph was compatible with severe motor and sensory neuropathy. An electroencephalogram showed widespread and symmetrical abnormality without response to tactile or auditory stimuli. At 19 days, hair loss began and parenteral nutrition was commenced. At 26 days a tracheostomy was performed; dialysis was stopped two days later, with the thallium level at 10 μg/l. At 35 days the ventilation was stopped, but there was no cough reflex so the tracheostomy was left in place.

On day 45, while undergoing a direct laryngoscopy, the patient suffered an episode of ventricular fibrillation. This was brought under control rapidly by d.c. shock; the pupils never dilated and he remained well perfused throughout the episode.

Psychiatric history

The staff of the Intensive Therapy Unit had become concerned about his mental state. It was still unclear how the thallium had entered his body, but his behaviour in ITU was the more pressing problem. When awake he would not comply with treatment, pulling out lines and catheters. He was periodically very 'agitated' and the staff felt that his withdrawal was deliberate. He was being given 40 mg of mianserin daily. A psychiatric assessment at this time revealed little evidence of depression, but much evidence of fatigue and irritability more likely to be an effect of a confusional state. The agitation, when observed, was found to be episodic myoclonus. Mianserin was discontinued.

His physical condition continued to improve steadily and he was transferred from ITU on day 52. Physiotherapy, speech therapy and occupational therapy were commenced. He continued to be irritable and difficult to manage. The major remaining problems by day 93 were poor compliance with physiotherapy and severe contractures of the knees.

Interviews with his parents and non-identical twin brother were carried out. He was of good premorbid personality, and up to the time of his illness had been living with his brother in a student flat. Up to the time of the illness neither the brother nor the parents had noticed any abnormality of mental state which might account for a deliberate attempt on his life. Investigations at the college revealed no explanation of how the thallium came to be ingested – neither any breakdown of safety regulations nor any suspicion of criminal poisoning. However, an amount of thallium roughly equivalent to the amount found in his body was missing from the laboratory. It was presumed that this was ingested by accident.

At school he had obtained ten O levels and four A levels at grade A, and was at the time of the presentation a final-year student of chemistry, planning to do a PhD. He was expected to obtain a first or upper second class degree. There was no history of excessive alcohol or drug use. His chemistry notes up to the time of his illness were well kept and showed no evidence of abnormal ideas concerning the substances on which he was experimenting, nor any sign of gradually diminishing abilities or of thought disorder. There was no family history of psychiatric illness.

Psychological testing

The evidence of a personality change, resting upon uncharacteristic hostility and aggressive outbursts, with foul language, suggested an organic component, and this suspicion was increased when he was found to be mildly disorientated during rehabilitation.

He was discharged to the National Spinal Injuries Centre at Stoke Mandeville Hospital for further rehabilitation. While he was there, psychometry was carried out by JD and PS, approximately seven months after initial presentation. The assessment was aided by his twin brother's willingness to undertake the same tests. The twin was of similar educational standard to the patient, having obtained ten O levels and three A levels (two grade A and one grade B) and being currently a final-year student in electrical engineering at the same college, and expected to achieve an upper second class degree. The following tests were performed on both subjects:

- National Adult Reading Test (NART; Nelson, 1982), to estimate previous intellectual function
- Wechsler Adult Intelligence Scale – Revised (WAIS–R; Wechsler, 1981) (as information and comprehension subtests of the WAIS–R were not yet available for use in England, the WAIS subtests were used)
- Wechsler Memory Scale (logical memory; Wechsler & Stone, 1973)
- Rey–Osterreith Figure (visual memory; Rey, 1959)

https://doi.org/10.1192/bjp.153.3.396 Published online by Cambridge University Press

TABLE I

Summary of intelligence test results (patient 7 months and 13 months after ingestion of thallium, twin at the same time as first testing of patient)

	Patient		
	(7 months)	*(13 months)*	*Non-identical twin*
NART(IQ)	124 (*superior*)	121 (*superior*)	121 (*superior*)
WAIS-R			
Full scale	*113 (high average)*	*117 (high average)*	*132 (very superior)*
Information[1]	14	14	15
Digit span	13	12	14
Vocabulary	16	12	12
Arithmetic	12	19	12
Comprehension[1]	16	10	11
Similarities	12	13	13
Verbal IQ	*128 (superior)*	*125 (superior)*	*121 (superior)*
Picture completion	10	12	12
Picture arrangement	8	11	13
Block design	14	13	19 (max)
Object assembly	9	12	18 (max)
Digit symbol	5	5	13
Performance IQ	*90 (average)*	*102 (average)*	*139 (very superior)*
Wechsler Memory Scale			
Immediate recall	11	12.5	11.5
Delayed recall (1 h)	4	8	9.5
% recall (1 h)	36 (<5th %ile)	64 (10–20th %ile)	85 (40–50th %ile)
Rey–Osterreith			
Delayed recall (40 min)	21/47 (20th %ile)	28/45 (50th %ile)	42.5/47 (90th %ile)
Warrington Recognition Memory			
Words	29 (<5th %ile)	34 (<5th %ile)	42 (75–90th %ile)
Faces	38 (5–10th %ile)	45 (50–75th %ile)	44 (50–75th %ile)
AH6 SEM			
Verbal	9 (<10th %ile)	10 (10–30th %ile)	19 (70–89th %ile)
Numerical	9 (<10th %ile)	13 (10–30th %ile)	12 (10–29th %ile)
Diagrammatic	6 (<10th %ile)	14 (30–50th %ile)	14 (30–69th %ile)
Total	24 (<10th %ile)	37 (10–30th %ile)	45 (30–69th %ile)

1. WAIS comprehensive and information subtests were used

Warrington Recognition Memory Test (Warrington, 1984)

AH6 SEM, a pencil-and-paper, self-completed timed test of general reasoning specifically designed for university science and engineering students (Hines *et al*, 1983).

The results are shown in Table I.

At the seven-month interview the patient was found to be right-handed, with a fine tremor, which did not prevent him from writing slowly. He co-operated fully with all tests and could see and read fine detail. He was on no medication.

The deficit in performance ability was due in part to slowness caused by hand tremor, but was probably due in part to real performance difficulties, most noticeable in sequencing and reasoning tasks.

There were significant difficulties in memorising both verbal and non-verbal material over a time span of 40 minutes to one hour. He had no recall at all for one short story after one hour. Recognition memory for faces and delayed recall of designs were impaired. The assessment of future studying abilities (AH6 SEM) showed severe impairment, the patient scoring in the bottom 10% on each test in spite of answering all questions.

Follow-up testing at 13 months after ingestion (Table I) showed little general improvement. However, on the arithmetic subtest he scored maximum points, and he was faster and more accurate in the picture completion and arrangement tasks than before. His immediate recognition for faces and delayed recall for designs had improved into the average range. His performance in the subtests of the AH6 SEM had also improved significantly.

The test results of the twin, to whom he was very similar in educational standard and estimates of premorbid intelligence, were consistently in the superior to very superior range of abilities.

Discussion

This is the first case in which detailed psychometric testing has been carried out on a patient with severe thallium poisoning. In this instance we were aided by the availability of a non-identical twin brother of very similar educational background. There are

https://doi.org/10.1192/bjp.153.3.396 Published online by Cambridge University Press

advantages to testing a non-identical twin over an ordinary sibling. Twins are of the same age and these two are known to have followed almost exactly the same career, with similar degrees of success. The NART confirms a similar premorbid IQ. Thus there are two reasons to believe that the differences between the twins were caused by the illness of the patient.

The verbal performance deficit of the patient cannot be entirely explained by the slowness and slight tremor, since tests which did not require this skill, such as sequencing and reasoning, were also impaired. The scores on the Wechsler Memory Scale also indicate a genuine dysmnesia.

To what extent can the effects of the illness be ascribed to the thallium? None of the treatments which he had, such as the chelating agents or haemodialysis, are known to have this effect, although dithiocarbonate is not frequently used and it is therefore impossible to state with certainty that it was not responsible for the CNS effects. However, the deterioration in the patient's condition during dithiocarbonate treatment was accompanied by an increase in thallium levels as the metal was drawn out of cells, and it is therefore likely that any deleterious effects were due to this action. There is a dementia associated with dialysis but this has only been documented after prolonged dialysis of renal patients (Lishman, 1978), and the four weeks of haemodialysis undergone by our patient are very unlikely to have caused the cognitive deficits here described.

It is possible that the cardiac arrest may have damaged the CNS, but the arrest took place in ITU and was immediately attended to. The pupils did not dilate, indicating that cerebral anoxia was not significant and therefore was very probably not responsible for the intellectual impairment. Thus this explanation is also unlikely.

It therefore appears that the thallium is the most likely cause of the psychological impairment documented in this patient, and this is the first time such an effect has been described in detail. The course up to 13 months after ingestion suggests that some recovery has occurred, but that this is slow, and a return to full premorbid function appears unlikely.

Acknowledgements

We are grateful to Dr W. A. Seed for permission to study the patient and for his helpful comments on the manuscript, and to Dr Angela Wainwright for the information on thallium levels.

References

GINSBURG, H. M. & NIXON, C. E. (1932) Thallium poisoning. *Journal of the American Medical Association*, **98**, 1076–1077.

GRINKER, R. R., SAHS, A. L. (1966) *Neurology* (6th edn). Springfield, Illinois: Thomas.

HINES, A. W., WATTS, K. P. & SIMMONDS, V. (1983) *AH6 Group Tests of High Level Intelligence*. Windsor: NFER-Nelson.

LISHMAN, W. A. (1978) *Organic Psychiatry*. Oxford: Blackwell.

NELSON, H. (1982) *National Adult Reading Test*. Windsor: NFER-Nelson.

REED, T. E., CRAWLEY, J., FARO, S. N., PIEPER, S. J. & KURLAND, L. T. (1963) Thallotoxicosis. *JAMA*, **183**, 516–522.

REY, A. (1959) *Le Test de Copie de Figure Complexe*. Paris: Edition Centre de Psychologie Appliqué.

WARRINGTON, E. (1984) *Recognition Memory Test*. Windsor: NFER-Nelson.

WECHSLER, D. (1981) *Wechsler Adult Intelligence Scale - Revised*. Windsor: NFER-Nelson.

—— & STONE, C. (1973) *Wechsler Memory Scale*. Windsor: NFER-Nelson.

*Christopher Thompson, MB, BSc, MPhil, MD, MRCPsych, *Senior Lecturer in Psychiatry, Charing Cross and Westminster Medical School*; J. Dent, *Senior Clinical Psychologist, Stoke Mandeville Hospital, Aylesbury*; P. Saxby, *District Psychologist, Aylesbury Vale Health Authority*

*Correspondence: *St Dunstan's Road, London W6 8RP*

British Journal of Psychiatry (1988), **153**, 399–402

Brain Imaging and Treatment Response in Spasmodic Torticollis

A patient with spasms of the neck, occurring when he turned his head to the left, responded to treatment with benzhexol. Cerebral blood flow imaging demonstrated reduced uptake in the right corpus striatum compared with the left. The study demonstrates

https://doi.org/10.1192/bjp.153.3.396 Published online by Cambridge University Press