INTRODUCTION

Lithium carbonate has been used to treat patients with bipolar disorder since 1949. However, the therapeutic index of lithium carbonate is relatively narrow, such that relatively small changes in dosing or in the patient’s condition may lead to poisoning. Acute lithium intoxication is associated with neurological manifestations such as tremor, ataxia, dysarthria, seizures, and in more severe cases encephalopathy and coma; patients experiencing such manifestations require rehabilitation. The authors present a patient who received post-acute rehabilitation for lithium toxicity-associated ataxia. Case: The patient was a man aged 30 years who had been diagnosed with bipolar disorder more than 10 years ago and had been prescribed lithium carbonate by a psychiatrist. The patient was admitted to the hospital with disturbance of consciousness, and physical therapy began on day 6 of hospitalization. Occupational therapy and speech therapy began on day 15. Physical therapy interventions focused on improving balance and coordination, and occupational therapy focused on improving stability while sitting, upper extremity control, and activities of daily living to improve the Functional Independence Measure motor subscale score. Speech therapy focused on dysarthria. On day 27 of hospitalization, the patient was able to walk 5 m with two Lofstrand crutches and could feed himself without assistance. From day 15 to day 30 of hospitalization, the Scale for the Assessment and Rating of Ataxia score improved from 28 to 19, and the Functional Independence Measure score increased from 25 to 77. On day 31, the patient was discharged to a convalescent rehabilitation hospital. Discussion: Post-acute rehabilitation for ataxia caused by acute lithium toxicity may improve ataxia and the ability to perform activities of daily living, and therefore may be of benefit.

CASE REPORT

Post-acute Rehabilitation for Ataxia Associated with Acute Lithium Toxicity: A Case Report

Ayumi Nobematsu, OTR a Hidetaka Wakabayashi, MD, PhD a Takuya Hanada, MD a Naoko Watanabe, RPT a and Kae Tachibana, MD b

Background: Acute lithium intoxication is associated with neurological manifestations such as tremor, ataxia, dysarthria, seizures, and in more severe cases encephalopathy and coma; patients experiencing such manifestations require rehabilitation. The authors present a patient who received post-acute rehabilitation for lithium toxicity-associated ataxia.

Case: The patient was a man aged 30 years who had been diagnosed with bipolar disorder more than 10 years ago and had been prescribed lithium carbonate by a psychiatrist. The patient was admitted to the hospital with disturbance of consciousness, and physical therapy began on day 6 of hospitalization. Occupational therapy and speech therapy began on day 15. Physical therapy interventions focused on improving balance and coordination, and occupational therapy focused on improving stability while sitting, upper extremity control, and activities of daily living to improve the Functional Independence Measure motor subscale score. Speech therapy focused on dysarthria. On day 27 of hospitalization, the patient was able to walk 5 m with two Lofstrand crutches and could feed himself without assistance. From day 15 to day 30 of hospitalization, the Scale for the Assessment and Rating of Ataxia score improved from 28 to 19, and the Functional Independence Measure score increased from 25 to 77. On day 31, the patient was discharged to a convalescent rehabilitation hospital.

Discussion: Post-acute rehabilitation for ataxia caused by acute lithium toxicity may improve ataxia and the ability to perform activities of daily living, and therefore may be of benefit.

Key Words: bipolar disorder; occupational therapy; physical therapy; speech therapy
CASE

Medical History

Figure 1 describes the patient’s treatment and outcomes. A 30-year-old man who had been diagnosed with bipolar disorder more than 10 years earlier had been prescribed lithium carbonate by a psychiatrist. However, his condition had been stable and the patient had not visited a hospital in the previous year. During that year, the patient had not taken his lithium carbonate medication. Consequently, the patient, who was on welfare and lived alone, was able to take an overdose with the unused medication. The patient was transported to the hospital with disturbance of consciousness.

Written informed consent was obtained from the patient for publication of this case report. This study was approved by the Research Ethics Committee of Yokohama City University.

The patient was found at home with disturbance of consciousness and was taken to the hospital. The patient was admitted with a serum lithium level of 3.79 mEq/L (therapeutic range, 0.6–1.2 mEq/L) (Fig. 2) and had a Glasgow Coma Scale (GCS) score of 10 (Eye opening response [E]=3, Verbal response [V]=T (Tracheotomy), and Motor response [M]=6; out of a possible 15 [E4V5M6]). Blood test results showed a lactate dehydrogenase level of 284 U/L, a creatinine level of 2.91 mg/dL, and a white blood cell count of 17,740 /µL.
Hemodialysis should be performed on any patient with lithium intoxication who presents with coma, convulsions, respiratory failure, deteriorating mental status, or renal failure. The patient underwent two hemodialysis treatments. After the first hemodialysis treatment, the patient’s serum lithium level decreased to 1.15 mEq/L. However, after 6 h, the serum lithium level had increased to 1.47 mEq/L, and hemodialysis was repeated. After the second hemodialysis treatment, the patient exhibited a reduction in consciousness disturbance but also exhibited severe limb and trunk ataxia and moderate dysarthria. Computed tomography scans of the patient’s brain at days 1 and 7 of hospitalization showed no abnormalities.

On day 6 of hospitalization, the patient started undergoing bedside physical therapy. By then, the patient had regained consciousness and had a GCS score of 13/15. The Manual Muscle Test (MMT) scores for the patient’s limbs and trunk were each 4. The range of motion testing showed that the patient had a normal range of motion. The patient’s Functional Independence Measure (FIM) score was 18 points, which was the sum of a motor subscale score of 13 points and a cognition subscale score of 5 points. Until day 8 of hospitalization, the patient was not allowed to leave the bed, and the physical therapist had the patient perform range-of-motion exercises. The doctor could not evaluate dysphagia, because the patient refused to undergo an evaluation.

On day 8 of hospitalization, the doctor could evaluate dysphagia. The repetitive saliva swallowing test was negative (more than three times in 30 s). In the modified water swallow test, breathing and voice quality were good, and the patient did not cough. Even though the patient had dysarthria, he had only slight dysphagia. Therefore, he started eating a normal diet on day 9 of hospitalization and complications did not occur.

On day 9 of hospitalization, the physical therapist began training the patient in sitting and standing at the bedside. Next day, the patient was able to walk for 3 m with a folding walker. During hospitalization, the patient did not take lithium carbonate. On day 2 of hospitalization, the patient started to take quetiapine fumarate at a dose of 100–400 mg, as needed. On day 6 of hospitalization, the patient took only quetiapine fumarate at a dose of 100 mg, before going to sleep. The discontinuation of lithium carbonate did not have a negative effect on the patient’s bipolar disorder.

**Physical Findings**

On day 15, ataxia was evaluated using the Scale for the Assessment and Rating of Ataxia (SARA), an assessment consisting of the following subscales: Gait, Stance, Sitting, Speech disturbance, Finger chase, Nose–finger test, Fast

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**Fig. 2.** The progress of the serum lithium level over time after the patient was hospitalized. The dotted line indicates the toxic threshold concentration. HD, hemodialysis.
alternating hand movements, and Heel–shin slide. SARA is a reliable and validated measure of ataxia, making it an appropriate primary outcome measure for clinical trials.\(^5\) Scores range from 0–40: a higher score indicates a worse condition. The patient’s score was 28. In a previous assessment of the usefulness of SARA, Kim et al. observed that independent gait, Q-cane gait, and walker gait were correlated with SARA scores of 8 or lower, >8 to 11.5, and >11.5 to 12.25, respectively.\(^6\) In addition, Kim et al.’s analysis of performance of ADLs showed that minimal dependence, moderate dependence, maximal dependence, and total dependence correlated with SARA scores of 5.5 or lower, >5.5 to 10.0, >10.0 to 14.25, and 23 points or higher, respectively.\(^6\)

To evaluate dysmetria while writing, the authors used the Runs test, line drawing tests, and circle drawing test. In the Runs test, a patient taps in a circle around the target 50 times at a distance of 10 cm away from the target. In the line drawing test, a patient connects two points 10 cm apart with a straight line. In the circle drawing test, a patient draws circles that do not touch each other.

Fine motor skills were tested with two types of peg tests: “in” and “flaps”. For the “in” test, a patient uses only one hand to put 48 pegs into 48 holes. “Flaps” is the same test as “In” but the patient instead has to turn 48 pegs over. The therapist uses a stopwatch and records the time it takes for the patient to complete the tests. The first time the patient took the test, he could not even hold any of the pegs.

To evaluate cognition, the authors used the Hasegawa Dementia Scale-Revised (HDS-R). Because of severe dysarthria, the patient could not speak well and did not want to speak at first. Therefore, the authors could not evaluate the patient’s performance on the HDS-R on day 15 of hospitalization. However, the patient’s FIM was 25 points (motor 14 points, cognition 11 points).

The speech therapist evaluated speech intelligibility as dysarthria. The result was a score of 3.5. A score of 3 means that the listener knows the subject and can understand what the patient is talking about. A score of 4 means that the listener does not understand most of the words that the patient is saying, and can understand only a few words.

**Rehabilitation Treatment**

On day 14 of hospitalization, the patient began a series of 40-min physical therapy sessions with one session per day for 5 days per week. On day 15, the patient began a series of 1-h occupational therapy and speech therapy sessions, and the physical therapy sessions were lengthened to 1 h. For ataxia, physical therapy focused on improving gait, balance, and coordination. Speech therapy focused on dysarthria.

On day 15, the patient’s GCS was 15/15 (E4V5M6). By that time, occupational therapy interventions had begun to focus on ADLs and upper extremity ataxia. The interventions were intended to increase the patient’s basic and instrumental ADL performance through environmental strategies and adaptive techniques to compensate for ataxia related movement disorders.\(^7\)

Occupational therapy was especially focused on sitting, stability, and on upper extremity control, including fine motor skills, handwriting, and ADLs. Improvements were assessed in terms of the FIM motor subscale score. The 3-month goal was that the patient would be able to care for himself, except for bathing. Therefore, we planned for the patient to be able to feed himself by the end of the first week of therapy.

Because of the trunk ataxia, the patient could not remain stable while sitting and therefore could not perform exercises well while sitting unaided. Consequently, the occupational therapist supported the patient’s pelvis: with this support, the patient practiced right and left arm reaching and also played catch.

The patient’s upper extremity ataxia affected his control of motion, eating, and handwriting. At first, we focused on improving the upper extremity ataxia. To improve eye–hand coordination, the occupational therapist guided the patient’s arm through specific motions repetitively. When the patient became used to these motions, the occupational therapist gradually offered less assistance. Also, for proprioceptive sensibility, the patient used 0.5 kg wrist weights and exercised with Rolyan Stacking Cones.

After the patient’s upper extremity ataxia improved and he was able to perform reaching motions smoothly, the patient began practicing fine motor skills and handwriting. For handwriting, the patient used pens with a weight attached to the top of the pen.

At the ward, the nurse had been assisting the patient with all ADLs, even helping him to eat. To help the patient learn to feed himself, the authors evaluated the utensils that the patient was using in the hospital ward. Prior to his evaluation, the patient would sit on the bed in a long seat position for his meal. However, the sitting aggravated his trunk ataxia and impaired his activity. Therefore, we had the patient sit in a wheelchair during meals instead.

**Follow-up and Outcomes**

Table 1 shows the results before and after rehabilitation. By day 27 of hospitalization, the patient’s GCS had improved over baseline to 15/15(E4V5M6). The patient could walk 5 m
with two Lofstrand crutches and could feed himself without assistance. His SARA score decreased from 28 to 19, and his FIM score increased from 25 to 77 (motor 59 points, cognition 18 points). MMT, Runs, and peg test results improved from day 15 to day 30. On day 30, the patient could answer the HDS-R and received a score. Speech intelligibility had a score of 2.5; a score of 2 means that sometimes the listener is not able to understand some words. Except for gait, stair climbing, and bathing, the patient’s ADLs at the ward required only moderate assistance, indicating moderate independence. Although the patient’s handwriting did not show significant improvement, it had improved to a degree where the authors could read some of his Japanese Kana words. The patient was discharged to a convalescent rehabilitation hospital on day 31.

**DISCUSSION**

We observed that over 1 month of rehabilitation, the patient’s lithium toxicity-associated ataxia decreased. The SARA score decreased by 9 points, and the FIM score increased by 52 points. The patient’s original symptoms were coma, ataxia, and dysarthria. According to the SARA results and the findings of Kim et al., the patient was predicted to be independent in basic ADLs and indoor gait using a cane. The results indicate that post-acute rehabilitation for acute lithium toxicity can improve ataxia and ADLs.

The patient’s serum lithium level decreased from the initial value after two hemodialysis treatments. After initiating hemodialysis, lithium levels have to be checked frequently and continually because serum lithium levels can rebound after hemodialysis as the intracellular lithium exits cells and reenters the bloodstream. In this case, the doctors checked the patient’s lithium levels over time and he received hemodialysis treatment twice. This intervention may have prevented the patient’s serum lithium level from increasing and likely facilitated his early rehabilitation treatment.

Post-acute rehabilitation may prevent muscle disuse atrophy and muscle weakness, improve ataxia, and lead to earlier recovery of physical functions and ADLs. We began the intervention aiming to increase the patient’s trunk stability for sitting, which in turn would help him to better control his upper extremities. Also, we had the patient use weighted pens to control ataxia in his hand while writing. Bonney et al. reported that evidence is equivocal for wrist weighting being beneficial: weighted wrist cuffs of different weights and weighted cutlery may be useful for some individuals under specific circumstances and should be assessed on a case-by-case basis. Thus, the patient’s goals and perspective should be considered when assessing the value of the intervention.

In this case, the use of weighted pens helped to improve the ataxia to a certain level. While the use of weighted pens and thick-barreled pens may be helpful, there is limited supporting evidence. Future studies are needed to further understand the benefit of the use of weights in rehabilitation of patients with ataxia. The patient had tattoos on his whole body, which precluded MRI examination. Therefore, the authors were not able to examine cerebellar signs.

Post-acute rehabilitation for ataxia caused by acute lithium toxicity, especially for preventing disuse muscle atrophy and muscle weakness and for enhancing trunk stability, may improve the performance of ADLs and should be performed.

**CONFLICTS OF INTEREST**

The authors declare that there are no conflicts of interest.

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**Table 1.** Scores and score ranges of measurements before and after rehabilitation interventions

<table>
<thead>
<tr>
<th>Measure</th>
<th>Possible scores</th>
<th>Day 15</th>
<th>Day 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS</td>
<td>15 (E4V5M6)</td>
<td>15 (E4V5M6)</td>
<td>15 (E4V5M6)</td>
</tr>
<tr>
<td>HDS-R</td>
<td>0–30 (cutoff 20)</td>
<td>NA</td>
<td>21</td>
</tr>
<tr>
<td>MMT</td>
<td>0–5</td>
<td>4/4</td>
<td>5/5</td>
</tr>
<tr>
<td>SARA</td>
<td>0–40</td>
<td>28</td>
<td>19</td>
</tr>
<tr>
<td>Runs test</td>
<td>0 (cm)</td>
<td>2.3/3.2</td>
<td>2.0/2.2</td>
</tr>
<tr>
<td>Peg test</td>
<td>0–100 (%)</td>
<td>In −/−, Flap −/−</td>
<td>In 24/25, Flap 18/20</td>
</tr>
<tr>
<td>FIM</td>
<td>18–126 (motor 13–91/ cognition 5–35)</td>
<td>25 (14/11)</td>
<td>77 (59/18)</td>
</tr>
</tbody>
</table>

NA, not applicable.

An HDS-R score below 20 indicates dementia.
REFERENCES