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Allied Health Rehabilitation of A Child With Anti-N-Methyl D-Aspartate (NMDA) Receptor Encephalitis – A Case Report on Presentation and Management

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ABSTRACT

This case report presents a review of a twelve-year-old female patient, with anti-NMDAR encephalitis who was referred for inpatient rehabilitation. This report describes therapy input and functional change over phases of recovery. A retrospective chart review was completed including collection of therapist activity, length of stay and functional change. The child's recovery appeared to reflect the stages of recovery described in the literature. Functional change, therapeutic strategies and clinician time are described. During the initial recovery phase, functional change was limited compared to the later phases where the rate of change was higher. This case highlights the need to evaluate the timing and model of rehabilitation, and for multidisciplinary team collaboration. Considering a modified model of rehabilitation during early phases of recovery may be useful to optimise patient outcomes and clinical resources. Use of functional outcome measures may support teams to evaluate services, optimise patient outcomes and resources.

Keywords: *Rehabilitation, Anti-NMDA Receptor Encephalitis, Allied Health, Multidisciplinary Team*

Introduction

Anti-N-methyl D-aspartate (NMDA) receptor encephalitis is an acute autoimmune disorder resulting in significant deficits from a neurological, behavioural, cognitive and physical perspective (Bach, 2014; Dalmau *et al*., 2007; Dalmau *et al*., 2019). Whilst the overall incidence is unknown, anti-NMDAR encephalitis is increasingly recognised as a leading cause of encephalitis in children and has been found to occur four times more frequently than other types of viral encephalitis in one paediatric cohort study (Bach, 2014; Dalmau *et al*., 2007; Gable *et al*., 2012). Of reported cases in this study, 65% were paediatric with females affected more frequently than males (Gable *et al*., 2012; Titulaer *et al*., 2013). Dalmau and colleagues (2008) reported that as many as 85% of adults with anti-NMDAR encephalitis initially presented to psychiatrists with symptoms including agitation, paranoia, visual and auditory hallucinations (Dalmau

et al., 2008). In comparison movement disorders and neurological symptoms were more commonly observed in children and adolescents, with 50% of children under 12 years presenting with movement disorders or seizures (Dalmau *et al*., 2008; Titulaer *et al*., 2013).

This autoimmune disorder is uncommon but tends to follow a predictable clinical course with five distinct clinical phases described in the literature (Bach, 2014; Iizuka *et al*., 2008; Titulaer *et al*., 2013). Iizuka *et al* (2008) define the first discreet phase as the 'Prodromal' phase where patients classically present with non-specific viral-like symptoms such as fever, headache, or fatigue (Bach, 2014; Iizuka *et al*., 2008). This is followed by the 'Psychotic' phase, characterised by psychotic, behavioural and/or emotional disturbances and cognitive decline which can include psychosis. Seizures may also occur during this phase (Bach, 2014; Iizuka *et al*., 2008). The third phase is considered the 'Unresponsive' phase, characterised by symptoms of a catatonic state, mutism and inability to follow instructions. This is followed by the 'Hyperkinetic' phase during which patients present with symptoms of an athetoid dystonic movement disorder including oral dyskinesias (lip smacking, jaw movements, teeth clenching, grimacing) and speech dysfunction (Bach, 2014; Iizuka *et al*., 2008). Bach (2014), describes the final stage as a 'Gradual Recovery' phase, defined as a period of slow recovery and a timeframe during which the earlier symptoms may recur.

Anti-NMDAR encephalitis results in deficits to multiple systems and early multidisciplinary input in the paediatric population is recommended to maximise functional recovery across all International Classification of Functioning (ICF) domains (Gable *et al*., 2012; Iizuka *et al*., 2008; World Health Organization., 2007). Despite the recommendation, identification of the most effective allied health model of care for rehabilitation is made more challenging by the paucity of information and differing approaches outlined in the literature. Generally, the literature pertaining to adolescents and adults, describes psychiatric admission in some cases (Dalmau *et al*., 2007; Florance *et al*., 2009), whereas paediatric case studies more commonly describe a rehabilitation model (Consoli *et al*., 2011; Houtrow *et al*., 2012; World Health Organization., 2007). Although multiple authors recommend a multidisciplinary rehabilitation approach (Bach., 2014; Consoli *et al*., 2011; Florance *et al*., 2009; Gable *et al*., 2012; Guo *et al*., 2014; Houtrow *et al*., 2012; Iizuka *et al*., 2008; Tham and Kong, 2012) including speech pathology, physiotherapy and occupational therapy, there is currently minimal information guiding timing of intervention, intensity of therapy or effective therapeutic strategies for allied health involvement or psychosocial interventions.

The paucity of research guiding allied health involvement makes it challenging to provide value-based healthcare across paediatric settings, and ensure that therapeutic input is timely, targeted and effective.

The following case describes a twelve-year-old female with Anti-NMDAR encephalitis who was referred for inpatient rehabilitation at a tertiary paediatric hospital in Brisbane. This single case study provides information on allied health staff activity, length of stay and functional change according to the Functional Independence Measure for Children (WeeFIM II) across the rehabilitation episode. Specific therapeutic strategies utilised by the allied health team are described relative to each clinical phase.

Case Presentation

The child was a previously well twelve-year-old prepubertal female, with a pre-existing diagnosis of Hirschsprung's Disease. She was admitted to a tertiary hospital in December 2018 after reporting progressively increasing symptoms of headaches, confusion, echolalia, dysarthria, and incontinence. Transfer to a specialist paediatric centre occurred seven days later. Initial investigations (CT head, MRI, lumbar puncture and EEG), were consistent with the diagnosis of acute encephalopathy. The child was subsequently treated with intravenous immunoglobulin (IVIG) and intravenous (IV) methylprednisolone. After identification of positive NMDAR antibodies in cerebrospinal fluid and a formal diagnosis of anti-NMDAR encephalitis, the child was medically managed with plasmapheresis, Rituximab, intravenous immunoglobulin therapy, intravenous Methylprednisolone and Prednisolone. The child spent approximately six weeks in the paediatric intensive care unit (PICU), exhibiting significant behaviours of severe agitation, confusion and psychosis, for which escalating dosages of sedatives and mood stabilising medications were required. The medications were steadily weaned over the next 16 weeks. Post discharge from PICU, the child spent four weeks on a medical ward prior to being transferred to the paediatric rehabilitation ward, to undertake an intensive rehabilitation program. The child was discharged from the rehabilitation ward after 25 weeks under care of the rehabilitation team (36 weeks total hospital admission) and attended a day rehabilitation programme for an additional nine weeks before being linked with local community therapists and supports. Following the day hospital block, the child continued to receive community-based therapy and was reviewed on a six monthly basis through a Hospital Clinic for a further three years.

Hours relating to occasions of service and contact hours were sourced from the individual patient timetables and the staff booking system. Allied health clinicians routinely record time and activity data for each patient daily through the hospital-based data collection system. This data was collated and abstracted on a Microsoft Excel 2010 spreadsheet.

The functional change in the child's performance was evaluated using the WeeFIM II (Uniform Data System for Medical Rehabilitation., 2006) which measures functional skill performance in children with physical or generalised limitations or restrictions. The WeeFIM II is a measure of performance that looks

at burden of care from a caregiver's perspective and consists of 18 items across self care, mobility and cognition. Each item is scored on a seven-level ordinal scale. The WeeFIM II assessment is used routinely within the inpatient unit to measure change within the rehabilitation episode of care. Each WeeFIM II assessment was completed by a staff member who had received formal training and accreditation through the Australasian Rehabilitation Outcomes Centre which is the centre holding the licence in Australia.

Descriptive statistics regarding length of stay (LOS), functional change (according to the WeeFIM II), occasions of service and treatment time were calculated for each of the three identified stages of recovery. The LOS data used to calculate the allied health usage was adjusted to reflect that activity only occurred during the week (Monday to Friday) as no rehabilitation allied health activity occurred over the weekend. The WeeFIM II efficiency for each of the stages (the change in functional score over the stage divided by the number of therapy days) was also calculated and reported.

The Children's Health Queensland Hospital and Health Service Human Research Ethics Committee confirms that this study was completed in the context of ethical best practice.

Presentation and Management

During the first ten weeks of her rehabilitation episode of care, the child presented as non-verbal, with a variable level of alertness combined with periods of agitation, consistent with the 'Unresponsive' phase of recovery described by Iizuka (2008). From weeks eleven to fifteen, the child's level of alertness increased as did features of agitation, disinhibition, oro-facial and limb dyskinesias, with perseverative motor movements, characteristic of the 'Hyperkinetic' phase. Due to clinical observations of key variations in presentation across the 'Gradual Recovery' phase, this has been divided into three section; 'Gradual Recovery' phases A, B and C. During weeks sixteen to twenty ('Gradual Recovery' phase A), the child demonstrated improved awareness of her environment and understood simple spoken information. She was able to communicate basic needs, wants and ideas using alternative and/or augmentative communication methods. There were significant improvements noted in verbal language and memory skills between weeks 21 and 25 ('Gradual Recovery' phase B) and she was discharged home during week 25. At time of discharge, the child demonstrated increased independence in activities of daily living and mobility, requiring supervision from a caregiver. From weeks 26 to 35 the child participated in a day rehabilitation program ('Gradual Recovery' phase C).

Functional Change

The child's function improved by 65 points across the 25-week inpatient stay, as scored on the WeeFIM II (Uniform Data System for Medical Rehabilitation., 2006). Continued improvements were noted during her day hospital programme but the final score remained below the maximal expected score for age of 126 points. The WeeFIM II efficiency scores were lowest during the 'Unresponsive' (0.32) and 'Hyperkinetic' phases (0.36) (Fig. 1). The greatest functional change was recorded during the 'Gradual Recovery' phases A and B (total WeeFIM II increase = 41) with increasing WeeFIM II efficiency scores noted (0.68/0.96) (Table 1). The greatest WeeFIM II efficiency was noted through 'Gradual Recovery' Phase C with an efficiency score of 1.38.

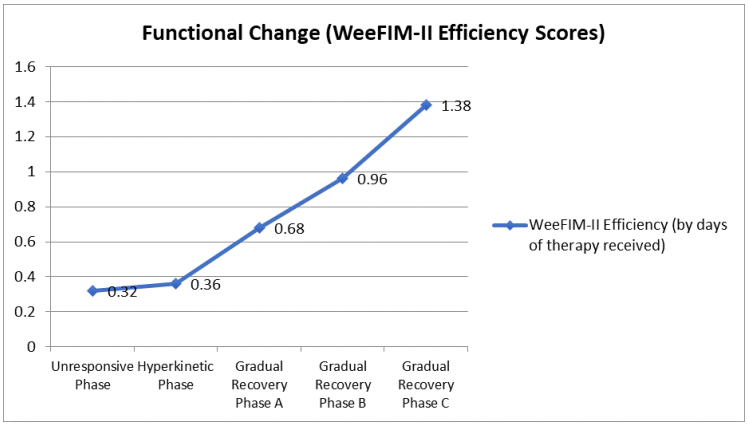

Figure 1: Functional Change (WeeFIM - II Efficiency Scores).

Table 1: Length of stay and Functional Independence Measure for Children (WeeFIM II) changes across rehabilitation period (inpatient and day hospital).

Phase	Total Length of Stay /Allied Health contact days	WeeFIM II change (Entry score/exit score)	WeeFIM II efficiency
Unresponsive Week 1-10	64/46	15 (27-42)	0.32
Hyperkinetic Week 11-15	35/25	9 (42-51)	0.36
Gradual recovery A Week 16-20	35/25	17 (51-68)	0.68
Gradual recovery B Week 21-25	35/25	24 (68 – 92)	0.96
Gradual recovery C Week 26 – 35 *Day Hospital Program	65/13	18 (92-110)	1.38

Allied Health Professional Contact

The child received a total of 464 hours of total allied health direct intervention over her inpatient admission (average 18. 5 hours per week) (Table 2). There was an additional 41 hours (average 6.8 per

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week) provided during the day rehabilitation program. The greatest average allied health professional hours per week occurred during the Gradual Recovery Phase B (22 hours) and the least within Gradual Recovery Phase C (6.8 hours). Occupational therapy, with a total of 123 hours, was the discipline with the greatest total direct clinical time during the child's inpatient admission. This was followed by speech pathology (88 hours), physiotherapy (82 hours), social work (59 hours) and music therapy (41 hours). The child received a total of 71 hours of direct support from allied health assistants during the inpatient rehabilitation phase of admission.

Table 2: Total allied health direct clinical time (hours) by recovery phase.

Phases	Total Allied Health (Hrs)	Average Allied Health Therapy per week (Hours)
Unresponsive	171	17.10
Hyperkinetic	77	15.40
Gradual Recovery Phase A	106	21.20
Gradual Recovery Phase B	110	22.00
Gradual Recovery Phase C	41	6.80
Total	505	14.85

Allied Health Management Strategies

Allied health therapists utilised an International Classification of Function (ICF) framework throughout the child's rehabilitation admission with an emphasis on activity and participation during the rehabilitation program (World Health Organisation, 2007). During the 'Unresponsive' Phase, the most successful therapy strategies were those that; i) increased arousal and ii) encouraged participation in familiar and motivating tasks. The use of sensory stimulating strategies, hand-over-hand support and parent education allowed the child to participate and succeed in meaningful tasks in a more consistent way (Table 3). During the 'Hyperkinetic' Phase, the primary foci for therapy were; i) participation in daily routine, ii) grading of cognitive demands in therapy and iii) management of the child's sensory-seeking behaviours. During this time there was a greater emphasis on psychosocial interventions for the family, and the ongoing need to simplify motor and cognitive demands using familiar and repetitive activities (Table 3). Within 'Gradual Recovery' Phase (A) the child progressed to actively participating in a full inpatient rehabilitation program. The focus in this phase was on supporting; i) the child's emerging communication skills and ii) participation in purposeful activities. The intervention strategies used in 'Gradual Recovery' Phase (B) and (C) centred around embedding learned therapy strategies into real life context. This included i) graded return to school, ii) community outings, iii) staged discharge from hospital with day passes and iv) supported weekend visits home. At this point, the family were able to engage in grief and adjustment counselling. Formal neuropsychology and language assessments were completed during 'Gradual Recovery' Phase (C), where the child was managed through a day rehabilitation model.

Table 3: Allied health professional strategies across phases of recovery.

	Overall Focus	Therapy Strategies to support domains
Phase 3 - Unresponsive Week 1-10	Building a routine Encouraging participation in motivating tasks Increasing arousal	***Daily occupations and Routine:*** Routine development and encouraging participation in daily routine. ***Communication/Feeding:*** Tastes and self-feeding practice. ***Psychosocial Interventions:*** Initial focus on rapport building and practical assistance with parents. Focus on crisis intervention and psychological debriefing with parents towards week 5. Begin attendance at Inpatient Parent Program. Psychoeducation - Parental coaching and hierarchy of supports handout. Regular Rehab Progress Meetings with parents. ***Cognition & Behaviour:*** Sensory strategies and movement to improve arousal. Errorless play – concrete and repetitive activities. Use of familiar repetitive tasks and environmental, tactile, visual and verbal prompts. ***Physical:*** Manual handling guidance and support for impulsivity. Mobility and stairs practice with support. Hand over hand to support initiation of movement & decrease perseveration.
Phase 4 - Hyperkinetic Week 11-15	Participation in daily routine Reducing expectations in therapy to 'Just Right' challenge Sensory strategies to support sensory seeking behaviours.	***Daily occupations and Routine:*** Daily timetable routine and use of a daily visual schedule. ***Communication/Feeding:*** Supporting communication and gestures including head shake for yes/no in context. Exploring voice including through use of music therapy with lyric mouthing. ***Psychosocial Interventions:*** Psychological debriefing, crisis intervention with parents, liaison and advocacy with key teams regarding parental concerns. Attendance at Inpatient Parent Program. Parental psychoeducation for management of behavioural concerns and need for support for all ADL's, mobilisation and constant supervision needs. NDIS planning meeting/ early discharge planning discussions ***Cognition & Behaviour:*** Behavioural management strategies implemented including: Limiting session times and reducing expectations of sessions with reduction in engagement and attention. Providing regular opportunities to participate in meaningful activities Grading sessions to 'just right'. Sensory strategies to support sensory seeking behaviours eg. Providing fidget toys, proprioceptive input, movement breaks, chewing gum for oral seeking behaviours. 2:1 school support. Neuropsychology observation of sessions. ***Physical:*** Supported gross motor program of familiar activities (basketball, walking, yoga) to assist in behavioural management and speech (counting) and provide enjoyment and engagement.
Phase 5a – Gradual recovery Week 16-20	Active rehabilitation participation in a full program	***Daily occupations and Routine:*** Commenced daily orientation board one-on-one with AHA, continued use of visual schedule. Continued increasing participation in ADLs using visuals, backwards chaining. ***Communication/Feeding:*** Modelling and multimodal communication with AAC use. Explicit teaching for greetings. Journaling for written expression and memory and handwriting/typing assist for speech production. ***Psychosocial Interventions:*** Grief and adjustment counselling with parents. Ongoing psychological debriefing and liaison and advocacy on behalf of family. Discharge planning, home visit planning and follow up and psychoeducation.

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		Regular Rehab Progress Meetings. ***Cognition & Behaviour:*** Starting to explore feelings, reason for hospitalisations and emotional expression. Supported community outings. Rewarding positive interactions. Purposeful activities and development of an interest profile to facilitate engagement. ***Physical:*** Contextual physical activities to improve motor control and co-ordination including attending hydrotherapy sessions and familiar supported activities child enjoys (trike riding, walking to the park).
Phase 5b – Gradual recovery Week 21-25	Active rehabilitation participation in a full program Embedding therapy strategies into context Social skills and community re-integration	***Daily occupations and Routine:*** Contextual practice for ADL's and community access. Initiated weekend passes to support towards discharge. ***Communication/Feeding:*** Social skills focus on group work. Extra time & phonemic cues for word retrieval. ***Psychosocial interventions:*** Grief and adjustment counselling with parents. Ongoing psychological debriefing and liaison and advocacy on behalf of family. Discharge planning and active problem solving. Regular Rehab Progress Meetings. ***Cognition & Behaviour:*** Explicit and contextual teaching for social skills (personal space, eye contact, maintaining conversation) including group therapy programs and outings (including community outing to a café, to a museum, travel on public transport with another inpatient and the therapy team). Supported home visit with therapist and child/family, and subsequent weekend passes to support towards discharge. Increased to daily school attendance. ***Physical:*** Supervision for outdoor mobility, working on high level mobility including running and return to sports activities with a focus on increasing endurance.
Phase 5c- Gradual recovery Week 26 – 35 Day Rehabilitation Program	Returning to activity, school and the community Formal assessments Transition	***Daily occupations and Routine:*** COPM completed with family for goal setting. ***Communication/Feeding:*** Improving speech fluency and clarity. ***Psychosocial Interventions:*** Grief and adjustment counselling, practical assistance, psychoeducation, liaison and advocacy with local services. ***Cognition & Behaviour:*** Assessment of technology needs for participation in school. Typing practice. Neuropsychology assessment. School telelink and graded return to home school. ***Physical:*** Assessment of coordination and gross motor skills and return to sport activities. ***Other:*** Linking in and liaising with local therapists for ongoing input.

Discussion

Paediatric rehabilitation is designed to improve the independence of children and adolescents who have lost function as a result of injury or disease and is characterised by the coordinated care of nursing, medical and allied health professionals (Ireland *et al*., 2017). This case highlighted a number of complexities associated with implementing a traditional rehabilitation program for a child with Anti-NMDAR Encephalitis during an inpatient admission. During this child's inpatient stay, the effectiveness of

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an intensive rehabilitation program, and the specific success of individual interventions appeared to be influenced by the specific phase of the disease process (Iizuka *et al*., 2008) that the child was experiencing at the time.

Literature suggests that children under a rehabilitation programme receive a minimum of 3 hours of therapy per day working under a goal directed model (Madi and Alraddadi, 2020). Noetzel and Dosenbach (2012) had previously noted that therapy should be instituted as soon as possible in order to maximise outcomes and reduce complications. While the child in this study was transferred to an intensive rehabilitation model ten weeks after initial hospital admission there were significant challenges with implementing both the intensity of therapy, and goal directed programmes recommended in the literature. During the initial 15 weeks of the rehabilitation programme, the child was considered to be in the 'Unresponsive' and 'Hyperkinetic' phases of recovery (Bach, 2014; Iizuka *et al*., 2008). During this time, she exhibited low levels of arousal and an inability to consistently follow simple commands, creating challenges in identifying appropriate goals for a targeted rehabilitation programme. Despite receiving the recommended intensity of therapy (three hours per day) suggested by Madi and Alraddadi (2020), there was minimal functional change observed on the WeeFIM II during the early phases of recovery, and significant challenges with applying a traditional goal directed therapy programme.

Because of challenges associated with implementing the more traditional goal directed rehabilitation model, the focus during the early admission shifted to become a more supportive model of care with a strong focus on family centred service and family-focused interventions. It has been well recognised that improved family functioning means that families are better equipped to support their child during a period of rehabilitation (Rosenbaum *et al*., 1998). Arcuri *et al*., (2016) highlighted that families felt more supported when there was clear and targeted information and communication to support them to act as experts in their child's care. Providing clear and targeted emotional support for parents, individualised information regarding a child's injury and inclusion in planning has been noted to help reduce a family's stress and anxiety (Keetley *et al*., 2019). As there was initially little change observed across the first 15 weeks in the child's recovery, there was a significant need to provide the family with emotional support, practical strategies including a reduction of session expectations and education regarding the variability in their child's daily presentation. Furthermore, the behaviours exhibited by the child in these early phases heightened the emotional and practical demands on the family, increasing the need for direct psychosocial interventions including opportunities to debrief and problem solve concerns.

The child's increased awareness of her surroundings and improved expressive communication suggested a transition into the 'Gradual Recovery' phase as described by Bach (2014). At this time, the focus

of therapy shifted to the more traditional, goal directed model of rehabilitation, with an increase in direct therapy hours and a more formalised goal setting process (Noetzel and Dosenbach, 2017). The primary focus became re-learning cognitive and communication skills through explicit teaching and practice within a real-life context. These skills were practiced within the context through community outings, return to a supported classroom environment, and regular passes home. During this 'Gradual Recovery' phase A, use of the Perceive, Recall, Plan, Perform (PRPP) (Chapparo and Ranka, 2020) assessment enabled therapists to more accurately identify areas of concern regarding cognition, and develop targeted interventions. The focus of psychosocial intervention shifted to grief and adjustment counselling, facilitating the family's adjustment to the changes in their child's function. The greatest positive change in function across all domains of the ICF (World Health Organisation, 2007) was observed during the Gradual Recovery phase, creating the period of greatest efficiency and the point at which a traditional rehabilitation model of care was able to be reintroduced. This case reinforces the need to evaluate the timing and model of rehabilitation offered to this group of patients in future and more accurately match the psychosocial and therapeutic interventions with the defined phases of recovery.

This single case study highlights the value of collaborative interdisciplinary teamwork. Consideration of multiple factors including length of admission, workload demands on therapist and changes on functional assessment (WeeFIM II) (Uniform Data System for Medical Rehabilitation., 2006) across the disease phases, suggests a need to consider alternative and more flexible models of early service delivery for this population. Implementing a transdisciplinary model of care with the key discipline worker principle (King *et al*., 2009) to support the child and family for the early phases of this disease may provide an improved balance between high value healthcare and efficient and cost-effective use of allied health time. The model of care may then shift from a more highly supportive model of care to a more traditional rehabilitation approach based upon targeted goal setting during a 'Gradual Recovery' phase.

Conclusion

This study provides data regarding allied health management and functional outcome according to the WeeFIM II, of a child with anti-NMDAR Encephalitis admitted to a rehabilitation unit at a tertiary children's hospital in Brisbane, Australia. Following reflection of this case, the team has identified and documented useful therapeutic strategies relative to both the phases of recovery and the child's level of functioning within these. Considering a modified model of rehabilitation service delivery for this patient group may be useful to ensure efficient use of therapist time and optimal patient outcomes. Further research in this area is recommended to ensure that allied health intervention is efficient for this population group and to identify those therapeutic strategies that are most effective.

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