

Appendix A: Treatment and exercise inventory - *Rehab for ataxia trial*

Exercises for rehabilitation outpatient and home-based intervention. Some exercises can be carried out in the hydrotherapy pool or on land, others are specific to the environment (i.e. turbulence – pool only).

Domain 1: Strengthening

Instructions:

- A. Resistance may be applied through: 1) Gym equipment; 2) Theraband; 3) Free weights; 4) Therapist-applied; or 5) Pilates springs.
- B. Strengthening may be focused on: 1) Eccentric control; 2) Repetition max dosage; 3) Movement quality (concentric control); 4) Movement quality and eccentric control; or 5) Eliciting contraction (for Oxford Grade 1+ and below muscle strength).
- C. Strengthening may occur: 1) Throughout range of movement; or 2) Defined range of movement.
- D. Facilitation includes: 1) Facilitation; 2) Support; 3) Modified Bad Ragaz method; 4) Turbulence (negative pressure - assistance) or 5) Assistance.

Below is the list of exercises that can be chosen for the *strengthening domain* (Table 1).

Table 1. Exercise List - Strengthening

Ankle plantarflexion	Ankle dorsiflexion	Ankle inversion	Ankle eversion
Ankle plantarflexion with buoyancy assistance	Ankle dorsiflexion with buoyancy assistance	Ankle inversion with buoyancy assistance	Ankle eversion with buoyancy assistance
Ankle plantarflexion with facilitation	Ankle dorsiflexion with facilitation	Ankle inversion with facilitation	Ankle eversion with facilitation
Ankle plantarflexion with resistance	Ankle dorsiflexion with resistance	Ankle inversion with resistance	Ankle eversion with resistance
Ankle plantarflexion with turbulence	Ankle dorsiflexion with turbulence	Ankle inversion with turbulence	Ankle eversion with turbulence
Knee flexion	Knee extension	Hip abduction	Hip adduction
Knee flexion with buoyancy assistance/resistance	Knee extension with buoyancy assistance/resistance	Hip abduction with buoyancy assistance/resistance	Hip adduction with buoyancy assistance/resistance
Knee flexion with facilitation	Knee extension with facilitation	Hip abduction with facilitation	Hip adduction with facilitation
Knee flexion with resistance	Knee extension with resistance	Hip abduction with resistance	Hip adduction with resistance
Knee flexion with turbulence	Knee extension with turbulence	Hip abduction with turbulence	Hip adduction with turbulence
Hip flexion	Hip extension	Hip internal rotation	Hip external rotation
Hip flexion with buoyancy assistance/resistance	Hip extension with buoyancy assistance/resistance	Hip internal rotation with buoyancy assistance/resistance	Hip external rotation with buoyancy assistance/resistance
Hip flexion with facilitation	Hip extension with facilitation	Hip internal rotation with facilitation	Hip external rotation with facilitation
Hip flexion with resistance	Hip extension with resistance	Hip internal rotation with resistance	Hip external rotation with resistance
Hip flexion with turbulence	Hip extension with turbulence	Hip internal rotation with turbulence	Hip external rotation with turbulence
Hip-knee extension: Squats	Hip-knee extension: Lunges	Hip-knee extension	Exercise Bike
Running down stairs	Bound down off step	Bounding	Hopping
Skipping	Scapular retraction	Scapular protraction	Shoulder IR

Shoulder ER	Shoulder flex	Shoulder ext	Shoulder elevation/depression
Other			

Domain 2: Postural Control

Instructions:

- A. Graded facilitation for all exercises to ensure quality movement using resistance, turbulence, buoyancy support, gravity support, equipment support and environment and facilitation techniques.

Below is the list of exercises that can be chosen for the *postural control domain* (Table 2).

Table 2. Exercise List – Postural Control

Pelvic ant/post tilt - sitting	Four-point kneeling – cat/cow	Bridging with pelvic tilt	Seaweeding
Pelvic ant/post tilt - lying	Four-point kneeling – hip extension	Bridging with pelvic tilt – leg to side	Rot control in supine using buoyancy
Pelvic ant/post tilt - standing	Four-point kneeling – hip extension & arm raise	Bridging with pelvic tilt – leg lift	Fixed ULs with LL rot
Pelvic ant/post tilt – 2-point kneeling	Four-point kneeling – arm raise rot	Bridging with pelvic tilt – one leg off bed	Standing – reaching laterally with buoyancy
Pelvic ant/post tilt – 4-point kneeling	Four-point kneeling – arm raise	Single leg bridging	Standing – reaching rot with buoyancy
Pelvic lateral tilt - sitting	Four-point kneeling – arm raise	Bridging off fitball	Standing with UL movement – flex/ext bilat with buoyancy
Pelvic lateral tilt - lying	Two-point kneel- alternate legs through to lunge	Supine – LL rot on top of fitball	Standing with UL movement – flex/ext unilat with buoyancy
Pelvic lateral tilt - standing	Sitting – rolling down	Supine – hip/knee flex/ext on fitball	Standing with UL movement – rot unilat with buoyancy
Thoracic flex/ext - sitting	Sitting – rolling down with rot	Two-point kneel – rolling ball fwd/fwd	Standing with UL movement – rot bilat with buoyancy
Thoracic flex/ext - lying	Standing – rolling down	Supine – unilateral hip eccentric IR – opposing leg stable	Standing with UL resisted movement – flex/ext bilat with buoyancy
Thoracic flex/ext - standing	Standing – rolling down with rot	Supine – unilateral hip ER with resistance – opposing leg stable	Standing with UL resisted movement – flex/ext unilat with buoyancy
Sit-ups	Supine balance on roll, knees bent	Sidelying hip ER	Standing with UL resisted movement – rot unilat with buoyancy
Sit ups with rot	Supine balance on roll, knees bent with unilateral shoulder horizontal extension	Sidelying hip ER with resistance	Standing with UL resisted movement – rot bilat with buoyancy
Standing – reaching laterally	Sitting – reaching laterally	Sidelying hip ER + IR	Standing – reaching laterally with turbulence
Standing – reaching rot	Sitting – reaching rot	Sidelying hip ER +IR with resistance	Standing – reaching rot with turbulence
Standing with UL movement – flex/ext bilat	Sitting with UL movement – flex/ext bilat	Prone thoracic extension	Standing with UL movement – flex/ext bilat with turbulence
Standing with UL movement – flex/ext unilat	Sitting with UL movement – flex/ext unilat	Prone cervical retraction	Standing with UL movement – flex/ext unilat with turbulence

Standing with UL movement – rot unilat	Sitting with UL movement – rot unilat	Sitting cervical retraction	Standing with UL movement – rot unilat with turbulence
Standing with UL movement – rot bilat	Sitting with UL movement – rot bilat	Sitting cervical retraction – resistance into wall	Standing with UL movement – rot bilat with turbulence
Standing with UL resisted movement – flex/ext bilat	Sitting with UL resisted movement – flex/ext bilat	Downward facing dog	Standing with UL resisted movement – flex/ext bilat with turbulence
Standing with UL resisted movement – flex/ext unilat	Sitting with UL resisted movement – flex/ext unilat	Side plank	Standing with UL resisted movement – flex/ext unilat with turbulence
Standing with UL resisted movement – rot unilat	Sitting with UL resisted movement – rot unilat	Side plank with leg movement	Standing with UL resisted movement – rot unilat with turbulence
Standing with UL resisted movement – rot bilat	Sitting with UL resisted movement – rot bilat	Side plank with rot	Standing with UL resisted movement – rot bilat with turbulence
Scapular retraction	Scapular protraction	Prone standing – hip extension	Should IR
Shoulder ER	Shoulder flex	Shoulder ext	Shoulder elevation/depression
Supine in pool reaching laterally/rotational control	Bilat hip/knee flex/ext while standing on noodle in pool	Supine, unilateral hip and knee ext/flx from flexed position - opposing leg stable	Other

Legend: UL = upper limb; LL = lower limb; ant = anterior; post = posterior; unilat = unilateral; bilat = bilateral; flex = flexion; ext = extension; IR: internal rotation; ER: external rotation; fwd = forward; bwd = backward; rot = rotation.

Domain 3: Functional Mobility

Instructions:

- A. Facilitated movement may be: 1) Facilitated; or 2) Supported.
 B. Resistance may be through: 1) Therapist-applied; 2) Theraband; or 3) Free weights.

Below is the list of exercises that can be chosen for the *functional mobility domain* (Table 3).

Table 3. Exercise List – Functional mobility

Bridging practice	Rolling practice	Sideways walking with turbulence	Sitting-to-lying practice
Facilitated bridging	Facilitated rolling	Lying-to-sit practice	Facilitated sitting-to-lying
	Rolling practice with buoyancy support	Facilitated lying-to-sit	Sitting-to-lying practice with buoyancy support
Sit-to-stand practice	Gait practice	Lying-to-sit practice with buoyancy support	Forwards walking
Sit-to-stand practice with resistance	Facilitated gait	Part-practice gait	Forwards walking with facilitation
Sit-to-stand practice with buoyancy support	Gait practice with buoyancy support	Facilitated part-practice gait	Forwards walking with buoyancy support
Sit-to-stand practice with turbulence	Gait practice with resistance	Part-practice gait with buoyancy support	Forwards walking with resistance
Backwards walking	Gait practice with turbulence	Turning practice	Forwards walking with turbulence
Backwards walking with facilitation	Sideways walking	Turning practice with buoyancy support	Stairs practice
Backwards walking with buoyancy support	Sideways walking with facilitation	Turning practice with turbulence	Facilitated stairs
Backwards walking with resistance	Sideways walking with buoyancy support	Walking in dynamic environment	Stairs practice with buoyancy support

Backwards walking with turbulence	Sideways walking with resistance	Walking with randomly prompted sudden directional changes	Stairs practice with turbulence
Walking with randomly cued sudden stopping	Walking with randomly cued head direction changes	Running	Floor transfers
Step ups/ downs with rotation	Walking stepping up and down curb	Walking on uneven surfaces with supervision	Other

Domain 4: Balance training

Instructions:

- A. Unpredictable movement may be: 1) Pilates springs or 2) Throwing and catching.
 B. Controlled movement may be: 1) Free range of movement; or 2) Theraband resistance.

Below is the list of exercises that can be chosen for the *balance domain* (Table 4).

Table 4. Exercise List - Balance

Static sitting balance	Wobble board lateral	Standing balance single leg with reaching to the floor and return
Static sitting balance with eyes closed	Wobble board anterior/posterior	Standing balance single leg with controlled lower limb movement
Sitting balance with neck rotation	Wobble board round	Standing balance single leg with unpredictable lower limb movement
Sitting balance with trunk rotation	Static standing balance step stance	Standing balance single leg with resisted lower limb movement
Sitting balance with controlled upper limb movement	Static standing balance tandem stance	Tandem walking
Sitting balance with unpredictable upper limb movement	Static standing balance step stance eyes closed	Sideways walking
Sitting balance with resisted upper limb movement	Static standing balance tandem stance eyes closed	Forward walking
Sitting balance with reaching to the floor and return	Static standing balance step stance on foam	Backwards walking
Sitting balance with controlled lower limb movement	Static standing balance tandem stance on foam	Half-rotation step
Sitting balance with unpredictable lower limb movement	Standing balance step stance with neck rotation	Turning practice
Sitting balance with resisted lower limb movement	Standing balance tandem stance with neck rotation	Stepping up/down step
Static standing balance feet apart	Standing balance step stance with trunk rotation	Side stepping up/down step
Static standing balance feet together	Standing balance tandem stance with trunk rotation	Step taps plus variations
Static standing balance feet apart eyes closed	Standing balance step stance with controlled upper limb movement	Weaving in/out of cones
Static standing balance feet together eyes closed	Standing balance tandem stance with controlled upper limb movement	Stepping over obstacles
Static standing balance feet apart on foam	Standing balance step stance with unpredictable upper limb movement	Walking on soft mat
Static standing balance feet together on foam	Standing balance tandem stance with unpredictable upper limb movement	Sit-to-stand
Standing balance feet apart with neck rotation	Standing balance step stance with resisted upper limb movement	Half sit-to-stand
Standing balance feet together with neck rotation	Standing balance tandem stance with resisted upper limb movement	Balancing on toes

Standing balance feet apart with trunk rotation	Standing balance step stance with reaching to the floor and return	Heel-raises
Standing balance feet together with trunk rotation	Standing balance tandem stance with reaching to the floor and return	Squats
Standing balance feet apart with controlled upper limb movement	Static standing balance single leg	Lunges
Standing balance feet together with controlled upper limb movement	Static standing balance single leg eyes closed	Weight-shifting in standing
Standing balance feet together with unpredictable upper limb movement	Static standing balance single leg on foam	Sit-to-stand plus one step
Standing balance feet apart with resisted upper limb movement	Standing balance single leg with neck rotation	Sitting balance on fitball
Standing balance feet apart with unpredictable upper limb movement	Standing balance single leg with trunk rotation	Sitting balance on fitball – alternate leg lift
Standing balance feet together with resisted upper limb movement	Standing balance single leg with controlled upper limb movement	Grapevine walking
Standing balance feet apart with reaching to the floor and return	Standing balance single leg with unpredictable upper limb movement	Standing and reaching
Standing balance feet together with reaching to the floor and return	Standing balance single leg with resisted upper limb movement	Sitting and reaching
Walking with randomly prompted sudden directional changes	Walking with randomly cued sudden stopping	Walking with randomly cued head direction changes
Balancing on pool equipment	Throwing/catching	Standing balance single leg with hip rotation- step over imaginary objects or up onto step
Big stepping to targets slow, fast and unpredictable	Backwards walking obstacle course	Other

Domain 5: Coordination and Control Exercises

Instructions:

- Concentrate on eccentric control and multi-joint facilitated exercises.
- Use targets to direct movement
- Use facilitation, resistance, verbal prompts if required

Below is the list of exercises that can be chosen for the *co-ordination and control domain* (Table 5).

Table 5. Exercise List – Coordination and control

Ankle dorsiflexion with facilitation	Ankle inversion with facilitation	Ankle eversion with facilitation	Facilitated ankle plantarflexion in lying
Ankle dorsiflexion with turbulence	Ankle inversion with resistance	Ankle eversion with resistance	Facilitated ankle plantarflexion in sitting
Facilitated ankle dorsiflexion with lengthening of the soleus muscle	Ankle inversion and hip adduction with resistance	Ankle eversion and hip abduction with resistance	Facilitated ankle plantarflexion in standing - bilateral
Knee extension with buoyancy assistance	Hip abduction with buoyancy assistance	Hip adduction with buoyancy assistance	Facilitated ankle plantarflexion in standing - unilateral
Knee extension with facilitation	Hip abduction with facilitation	Hip adduction with facilitation	Supine – unilateral hip eccentric IR – opposing leg stable
Hip extension with buoyancy assistance	Hip internal rotation with buoyancy assistance	Hip external rotation with buoyancy assistance	Supine – unilateral hip ER with resistance – opposing leg stable

Hip extension with facilitation	Hip internal rotation with facilitation	Hip external rotation with facilitation	Sidelying hip ER
Knee extension with facilitated hamstring lengthening	Sit-to-stand with theraband to increase hip ER activity	Squats with theraband to increase hip ER activity	Sidelying hip ER with resistance
Hip-knee extension: Lunges - facilitated	Alternate hip/knee flexion/extension on pilates table	Facilitated shoulder protraction-retraction	Sidelying hip ER + IR
Hip-knee extension: Leg press - facilitated	Exercise Bike	Ballistic mini tramp alternate ankle dorsiflexion/plantar flexion	Sidelying hip ER +IR with resistance
Bounding	Grapevine walking	Skipping	Switch lunges
Supine unilateral hip/knee extension +/- alternate legs	Stepping to targets	Step taps plus variations	Passing ball around legs/trunk
Unilateral hip/knee extension on fit ball	Unilateral hip/knee extension on pool noodle	Throw and catch with 360° turns	Catching with step lunge unpredictable
Other			

Legend: ER = external rotation; IR = internal rotation.

Domain 6: Sensory stimulation, mobilisation and stretching, and vestibular rehabilitation

Instructions:

The aim of stretching, mobilising and sensory stimulation is to allow functional retraining and strengthening in the most beneficial position. Therefore, these exercises/techniques should occur prior to the active activity aimed for (i.e. calf stretch for part-practice gait focusing on terminal phase of stance).

Below is the list of exercises that can be chosen for the *Sensory stimulation, mobilisation and stretching domain* (Table 6).

Table 6. Exercise List - Sensory stimulation, mobilisation and stretching

Closed-chain metatarsophalangeal flexion practice	Ankle inversion with resistance.	Soft-tissue massage of the gastrocnemius
Closed-chain metatarsophalangeal flexion facilitation	Ankle eversion with resistance.	Soft-tissue massage of the soleus
Phalangeal flexion – all toes practice	Calf raises with eccentric lengthening practice	Soft-tissue massage of the foot.
Phalangeal flexion – all toes facilitation	Calf raises with eccentric lengthening with facilitation	Static gastrocnemius stretching in standing.
Interphalangeal joint flexion – isolated toes practice	Static hip adductor stretch in lying	Static gastrocnemius stretching in lying.
Interphalangeal joint flexion – isolated toes facilitation	Thoracic rotation stretch in sitting	Static gastrocnemius stretching in lying, with therapist
Pick up small objects with toes practice	Thoracic rotation stretch in lying	Static soleus stretching in sitting.
Selective toe metatarsophalangeal flexion practice	Static psoas stretch in lying with therapist	Static soleus stretching in sitting, with therapist
Selective toe metatarsophalangeal flexion facilitation	Static psoas stretch in lying	Static soleus stretching in standing.
Facilitated first toe circumduction	Static psoas stretch in standing	Static tibialis anterior stretch in sitting
Facilitated fifth toe circumduction.	Static hip adductor stretch in lying with therapist	Static tibialis anterior stretch in sitting with therapist
Facilitated ankle dorsiflexion with lengthening of the soleus muscle, with subtalar joint accessory movements	Latissimus dorsi stretch	Accessory movements of metatarsal bones
Facilitated ankle dorsiflexion with lengthening of the soleus muscle,	Soft-tissue massage of psoas	Accessory movements of the subtalar joint

without subtalar joint accessory movements		
Lateral flexion trunk	Soft-tissue massage of adductors	Thoracic mobilisations
Rotation of trunk	Soft-tissue massage pectorals	Thoracic mobilisations with buoyancy
Gaze stabilization in sitting	Gaze stabilization in standing feet apart	Other