VIP-START Program

SHORT TERM ACCELERATED REHABILITATION FOR TRAUMA

VETERAN INTENSIVE PROGRAMME

A 4-Week Intensive, Multidisciplinary, Neurorehabilitation Program with The Accelerated Recovery Centre (ARC) and Australian Centre for Trauma in Veterans (ACTIV)

Disclaimer: This prospectus outlines the clinical rationale and structure of the VIP-START Program. Treatment is highly individualised; not every modality or intervention described is indicated for every patient.

Executive Summary

In veterans, TBI arises from multiple mechanisms: direct blast overpressure, blast wind that rapidly accelerates the head, repeated artillery or breaching exposure, concussive impact, and mixed trauma across deployments. These injuries can produce acute and chronic problems spanning headaches, dizziness, insomnia, tinnitus, memory loss, slowed attention, executive dysfunction, irritability, mood change, anxiety, PTSD overlap, and impaired daily functioning. Repeated blast exposure is also linked to complex comorbidities, including chronic pain, neurobehavioral symptoms, depression, suicidal ideation, and possible later neurodegeneration. Overall, TBI in veterans is not a single injury but a cumulative brain-health burden shaped by frequency, intensity, and recovery time over years of service and training exposures alike.

The Veteran Intensive Programme - Short Term Accelerated Rehabilitation for Trauma (VIP-START) Program is a highly structured, intensive four-week multidisciplinary neurorehabilitation initiative delivered by the Accelerated Recovery Centre (ARC) in Queensland geared specifically to Veterans with Traumatic Brain and Spinal Cord Injuries including Chronic Traumatic Encephalopathy (CTE) and the associated comorbidities occurring with Veteran TBI.

Designed specifically for individuals recovering from acquired brain injury (ABI), spinal cord injury (SCI), complex neurological trauma, and pervasive nociplastic chronic pain syndromes, the VIP-START Program represents a fundamental paradigm shift in the delivery of outpatient rehabilitation. While beneficial for baseline maintenance, this low-dosage, low-intensity approach frequently fails to provide the profound volume of repetitive, task-specific practice required to induce meaningful, durable cortical reorganisation.

The Accelerated Recovery Centre (ARC) and Australian Centre for Trauma in Veterans (ACTIVE)

The Accelerated Recovery Centre (ARC) focuses on Neuroplasticity-based approaches to rehabilitation. ARC uses state-of-the-art technology with Robotics, Artificial Intelligence, Virtual Reality, Gamification, Exoskeletons, and Functional Electrical Stimulation and offers intensive programmes to maximise the neuroplasticity response and speed up recovery for people TBIs and SCI. The Australian Centre for Trauma in Veterans (ACTIV) focuses on multidisciplinary treatment approaches for veterans with multiple comorbidities brining in neurologists, neuropsychiatrists, psychologists, pain specialists, rehab specialists, occupational therapists, physiotherapists, exercise physiologists, and nutritionists recognizing the complexities of working with chronic pain, PTSD, depression, moral injury, seizures, polypharmacy, cognitive impairments, mobility dysfunction, sexual dysfunction, tinnitus, hearing loss, bruxism, sleep disorders and relationship and family issues resulting from trauma in Australian Veterans.

Crucially, the VIP-START Program acknowledges that complex trauma does not present in neat diagnostic silos. Acquired neurological injury is virtually always accompanied by profound cardiovascular deconditioning, autonomic dysregulation, intractable chronic pain, sleep architectural disruption, and significant psychological trauma. Consequently, the four-week intensive structure provides a holistic, interdisciplinary wrap-around service. Our team of neurologists, psychiatrists, rehabilitation physicians, physiotherapists, occupational therapists, exercise physiologists, pain specialists and clinical psychologists work together to provide a full multidisciplinary approach.

ARC's clinical environment is designed to foster intensive, measurement-based rehabilitation

Advanced robotics provide the high-dose repetition required to overcome the recovery plateau.

Key Features of the VIP-START Program

- **4-Week Intensity:** A compressed timeframe designed to maximise neuroplastic adaptation and functional throughput.
- **10+ Discipline Team:** Unparalleled access to medical specialists, psychologists, and allied health professionals operating under one roof.
- **Integrated Comorbidity Care:** Simultaneous, rather than sequential, treatment of pain, mental health, mobility, cognition, and sleep.
- **Measurement-Based Practice:** Continuous, objective tracking of biomechanical and psychosocial metrics to prove clinical efficacy.
- **Home Transition Plan:** Focus on ensuring clinic-based gains are engineered into sustainable, long-term home and community routines.

REFERRAL AND ENROLMENT NOTE

Referrals, suitability screening, and individualised treatment planning are completed following interdisciplinary assessment. Not every modality or intervention described in this prospectus is appropriate for every patient; the final program design is tailored to clinical goals, risk profile, comorbidity profile, and readiness for intensive rehabilitation.

The Accelerated Recovery Centre welcomes enquiries from referring clinicians, general practitioners, specialists, insurers, the National Disability Insurance Scheme, workers' compensation schemes, the Department of Veterans' Affairs, case managers, patients, and families. We look forward to partnering with you on an evidence-based, neuroplasticity-informed rehabilitation pathway.

The 4-Week Intensive Program

The VIP-START Program is not merely a collection of isolated therapies; it is a meticulously engineered clinical protocol. The ARC methodology and architectural design, daily rhythms, and governance structures make intensive interdisciplinary rehabilitation possible, safe, and effective.

Program Design Principles

The architecture of theVIP-START Program is dictated by the biological rules of experience-dependent neuroplasticity. Seminal neuroscience literature establishes that for the brain to structurally reorganise, training must be highly specific to the desired outcome (task specificity), intensely meaningful to the patient (salience), and delivered at massive volume (dose and repetition).

The science of intensive time-limited rehabilitation demonstrates that concentrating therapy into a condensed block (e.g., four weeks) drives faster and more durable cortical map expansion than distributing the exact same number of therapy hours over twelve months. The biological rationale for a four-week duration is precise: it provides sufficient time to navigate the acute inflammatory response to new exercise, acquire new motor and cognitive skills, and consolidate those skills into associative memory, without subjecting the patient to the institutional fatigue that often accompanies longer Programs. Program fidelity is maintained through protocolised delivery, ensuring that while individual goals vary, the intensity and interdisciplinary methodology remain uncompromisingly consistent.

A Typical Day in the VIP-START Program

A day in the VIP-START Program is demanding. It requires careful orchestration of cognitive load, physical exertion, and autonomic regulation. Fatigue monitoring is paramount; therapists utilise the Borg Rating of Perceived Exertion (RPE) and objective heart rate variability to ensure patients are challenged but not overwhelmed. The day is designed to alternate high-demand motor tasks with psychological or educational interventions that require different cognitive resources.

Clinical Activity	Primary Disciplines	Core Focus
Medical Review & Cognitive Priming	Rehab Physician, Neuropsychologist	Spasticity check, goal alignment, executive function tasks.
High-Intensity Motor Relearning	Physiotherapist	Overground gait kinematics, Tecnobody D-WALL balance, body-weight supported treadmill.
Scheduled Rest & Pacing	Rehab Nurse	Hydration, autonomic down-regulation, fatigue monitoring.
Robotic Upper Limb Translation	Occupational Therapist	Tyromotion DIEGO/AMADEO for high-dose arm/ hand repetition, VR ADL simulation.
Lunch & Unstructured Recovery	Dietitian (if supervised)	Nutritional support, peer interaction, unstructured cognitive rest.
Metabolic Conditioning	Exercise Physiologist	Cardiorespiratory loading, core stabilisation, strength conditioning.
Psychological Adjustment & Pain	Clinical Psychologist, Pain Specialist	Trauma-focused CBT, Pain Neuroscience Education, EMDR, pacing strategies.
Neuromodulation & Integration	Interdisciplinary	tDCS/TMS application, targeted FES, daily debrief, mindfulness wrap-up.

VIP-START Program

The weekly rhythm balances intense therapy days with crucial periods for assessment, case conferencing, and family integration. This rhythm ensures that the Program remains agile, responding dynamically to the patient's evolving presentation.

Day	Morning Focus	Afternoon Focus
Monday	Weekly Goal Setting, Medical Clearance	Intensive Motor & Cognitive Therapy
Tuesday	Technology-Augmented Motor Therapy	Psychology, Pain Management, FES
Wednesday	Robotics, VR Rehab, Endurance	Fatigue Management, Fine Motor ADLs
Thursday	Intensive Gait, Balance, Upper Limb	Psychology, Relationship Counselling
Friday	Consolidation, Objective Re-Assessment	Home Program Practice, Family Education

Program Outline Over Weeks

While detailed clinical protocols are provided in Section 8, the conceptual arc of the four weeks moves from Acquisition to Consolidation to Translation. Week 1 prioritises high-resolution baseline mapping and acclimatisation to the technology. Week 2 scales up the therapeutic dose aggressively to drive neuroplastic skill acquisition. Week 3 layers cognitive and environmental complexity (dual-tasking, VR scenarios) to consolidate learning. Week 4 focuses relentlessly on translating clinical gains into sustainable community and home-based routines.

Interdisciplinary Integration

Our programs are supported by a collaborative multidisciplinary approach that enables medical teams and support services to communicate effectively and remain informed about each participant's progress, health needs, and treatment goals. Regular clinical reviews and coordinated care planning ensure that all members of the care team have access to relevant information, allowing services to be responsive, consistent, and tailored to the individual's needs throughout their rehabilitation journey.

This integrated model of care supports seamless communication between medical, nursing, psychology, allied health, and support staff, helping to provide a connected and person-centred rehabilitation experience. Through shared care planning, progress monitoring, and ongoing collaboration, participants receive coordinated support designed to maximise engagement, wellbeing, and long-term recovery outcomes.

Program Outcomes Framework

TheVIP-START Program assesses recovery across the full spectrum of the World Health Organization's (WHO) International Classification of Functioning, Disability and Health (ICF). We measure impairment (e.g., grip strength via PABLO, spasticity via Modified Ashworth), activity (e.g., 10-Metre Walk Test, Functional Independence Measure [FIM]), and participation (e.g., Mayo-Portland Adaptability Inventory [MPAI-4], Return to Work metrics). Pain, mood (PHQ-9, GAD-7, PCL-5), and caregiver burden are routinely quantified, ensuring that our outcome reporting satisfies the rigorous demands of insurers, the NDIS, and referring specialists.

Safety, Monitoring, and Quality

Intensive neurorehabilitation carries inherent risks, particularly concerning cardiovascular stress, falls, and seizure provocation. Clinical governance is stringent. Adverse event monitoring is continuous, with explicit medical escalation pathways to the onsite Rehabilitation Physician and Neurologist. Technologies such as SMART GRAVITY physically eliminate fall risk during gait training. Fatigue is aggressively managed, acknowledging that pushing a neurologically compromised patient into exhaustion is counter-therapeutic and unsafe.

Family, Carers and Community Partners

Rehabilitation that exists only inside a clinic is inherently flawed. Family members and primary carers are integral members of theVIP-START team. They are provided with structured education regarding neuroplasticity, behaviour management, safe transfer techniques, and psychological support. Furthermore, we actively partner with the patient's existing community clinicians (GPs, local therapists) to ensure that ARC serves as an accelerator within their broader care journey, rather than a disruptive silo.

Transitions and Continuity of Care

Discharge is not an endpoint; it is a transition. Pre-admission planning identifies the required post-discharge environment. In Week 4, a highly detailed, ecologically valid home exercise Program is curated. Formal clinical handovers are generated for all community stakeholders. To safeguard the neuroplastic gains achieved during the Program, ARC schedules formal "booster reviews" at 6 weeks, 3 months, and 6 months post-discharge, tracking long-term maintenance and intervening early if deterioration occurs.

Comprehensive Multidisciplinary Team

At ARC, we believe the most important technology is our team. While our robotic and biomechanical systems are world-class, it is the expertise, clinical insight, and collaborative approach of our specialised staff that truly drives meaningful rehabilitation outcomes.

Our Team

The strength of theVIP-START Program lies in its highly integrated multidisciplinary team, which brings together medical, psychological, community support, social work, dietetic, and rehabilitation professionals within a single coordinated model of care. Research consistently shows that collaborative multidisciplinary rehabilitation improves clinical outcomes, enhances communication, enables earlier intervention, and supports more personalised treatment pathways. By building a strong, co-located team, we reduce delays often associated with fragmented community-based care and provide participants with timely, consistent, and comprehensive support throughout their recovery journey.

- Clinical Psychologist
- Dietician
- Exercise Physiologist
- Neurologist
- Occupational Therapist
- Orthopaedic Specialists
- Pain Specialists
- Physiotherapist
- Psychiatrist
- Rehabilitation Nurses
- Rehabilitation Physicians
- Sexual Health Counsellor
- Speech Pathologist
- Social Workers

Integrated Treatment of Complex Comorbidities

Complex trauma is never one problem; it is a constellation of interacting, co-occurring crises. A patient does not simply have a spinal cord or acquired brain injury; they have neuropathic pain, which causes insomnia, which exacerbates depression, which severely limits their motivation to participate in physical therapy. Successful rehabilitation must treat these comorbidities simultaneously, not sequentially.

MENTAL HEALTH

Presentations: PTSD, severe depression, crippling anxiety, adjustment disorders, and organic mood changes directly linked to frontal lobe injury.

START Integration: Concurrently treated via psychiatric pharmacology, clinical psychology (trauma-focused CBT, EMDR, ACT, DBT), and group therapy, carefully paced so that emotional exhaustion does not derail physical rehabilitation.

CHRONIC PAIN

Presentations: Nociceptive (structural), neuropathic (nerve damage), central sensitisation (nociplastic), post-traumatic headache, and compensatory musculoskeletal pain.

START Integration: Pain specialist oversight paired with psychology (pacing/education), physiotherapy, neuromodulation (tDCS/TMS), Graded Motor Imagery (GMI), mirror therapy, and VR therapy.

MOBILITY ISSUES

Presentations: Hemiparetic gait, profound balance deficits, upper-limb spasticity or flaccidity, transfer inability, and wheelchair reliance

START Integration: Aggressive intervention via physiotherapy and occupational therapy, heavily amplified by robotic repetition (DIEGO, AMADEO), body-weight-supported gait (SMART GRAVITY), balance technology, and exercise physiology.

SEIZURES

Presentations: Post-traumatic epilepsy, focal or generalised seizures, aura symptoms, and medication-induced lethargy.

START Integration: Neurologist and rehab physician screening, anti-epileptic drug (AED) optimisation, nursing observation, and strictly modified safety protocols for technologies like tDCS, TMS, and immersive VR.

COGNITIVE IMPAIRMENT

Presentations: Deficits in sustained attention, working memory, executive function (planning/inhibition), processing speed, and receptive/expressive language.

START Integration: Neuropsychology assessment driving OT and speech pathology interventions, frequently utilising gamified cognitive-motor technology (MYRO) to train dual-tasking safely.

SLEEP PROBLEMS

Presentations: Severe insomnia, undiagnosed sleep apnoea, circadian rhythm disruption, and resultant debilitating daytime fatigue.

START Integration: Medical screening for apnoea, Cognitive Behavioural Therapy for Insomnia (CBT-I), strict sleep hygiene protocols, circadian-aligned exercise prescription, and psychiatric support.

FATIGUE

Presentations: Neurofatigue (brain drain), physical exhaustion, metabolic depletion, and post-exertional malaise.

START Integration: Continuous Borg RPE monitoring, rigorous pacing strategies designed by OT and psychology, metabolic rebuilding by exercise physiology, and nutritional support.

MEDICAL COMORBIDITIES

Presentations: Autonomic dysregulation (blood pressure swings), neurogenic bladder/bowel, severe spasticity, and vulnerability to pressure injuries.

START Integration: Rehab physician oversight, meticulous nursing care (continence and skin management), physiotherapeutic positioning, and dietetic support.

NEUROPSYCHIATRIC

Presentations: Post-traumatic agitation, disinhibition, profound apathy, emotional lability, and dangerous impulsivity.

START Integration: Joint management by psychiatry and neuropsychology to formulate explicit behavioural management plans, alongside extensive family education and staff training to ensure consistent responses.

RELATIONSHIPS & INTIMACY

Presentations: Altered sexuality post-injury, profound relationship strain, role reversal (partner to carer), and family system breakdown.

START Integration: Dedicated sexual health counsellor, clinical psychologist, and social worker interventions, guided explicitly by the INTIMASY-TBI clinical practice framework.

Week-by-Week Clinical Protocols

The VIP-START Program is a carefully phased, 4-week clinical protocol that mirrors the neurobiological trajectory of motor relearning, pain modulation, and functional restoration. Grounded in motor learning theory, it moves the patient systematically through cognitive acquisition, associative consolidation, and autonomous performance.

Week 1 Assessment, Acclimatisation, and Baseline Mapping

Week 1 prioritises high-precision measurement. The objective is not to exhaust the patient with repetition, but to generate a comprehensive biomechanical, neurophysiological, and psychosocial portrait. Every subsequent clinical decision is dose, device selection, rest ratio, and progression is mathematically and clinically traceable back to this Week 1 baseline.

WEEK 1 PRIMARY CLINICAL ACTIVITIES

- **Medical Admission & Risk Stratification:** Medication reconciliation, autonomic screening, spasticity grading (Modified Ashworth Scale), seizure risk assessment, and suitability screening for neuromodulation (tDCS/TMS).
- **Tecnobody D-WALL Elite Assessment:** Full postural, gait, and functional movement screening. Overhead squats, single-leg balance, gait kinematics, and pelvic symmetry are quantified and stored via the HOMING cloud.
- **TYMO Posturography:** Standardised static and dynamic Centre of Pressure (COP) assessments (eyes open/closed) to quantify visual versus proprioceptive dependence.
- **Tyromotion PABLO Force Profiling:** Objective quantification of grip, pinch, cylinder, and interdigital strength, alongside wrist ROM across three motion axes.
- **AMADEO Digit-Level Assessment**: Individualised ROM, tone, and spasticity metrics per digit. Crucial EMG screening to identify residual voluntary drive in seemingly "flaccid" hands.
- **MYRO Cognitive-Motor Screen:** Baseline measurement of divided attention, visual-spatial exploration, and upper-limb force control during dual-task conditions.
- **ProKin Proprioceptive Mapping:** Ankle and knee joint position sense tested in static and dynamic instability modes.
- **Balance Trunk Core Assessment:** Pelvic tilt awareness and trunk control quantified in seated gamified tasks.
- **Exercise Physiology Baseline:** Submaximal cardiorespiratory testing (where safe), handheld dynamometry, and body composition analysis.
- **Psychology Battery:** Administration of PHQ-9, GAD-7, PCL-5, Pain Catastrophising Scale, Tampa Scale for Kinesiophobia, Chronic Pain Acceptance Questionnaire, and structured goal elicitation.
- **Occupational Therapy Assessment:** Canadian Occupational Performance Measure (COPM), FIM, MPAI-4 where applicable, and task analysis of priority activities of daily living.

By the end of Week 1, the team convenes for a formal case conference. A shared, measurable, and realistic four-week goal set is agreed with the patient and their family. Where neuromodulation is indicated for example, anodal tDCS over M1 in a patient with refractory neuropathic pain, medical clearance and consent are finalised during this week. Importantly, Week 1 also includes a deliberate desensitisation to the technology itself: patients with pain-related fear or anxiety are systematically exposed to each device at sub-threshold intensities before therapy begins in earnest.

Week 2 Skill Acquisition and Therapeutic Immersion

Week 2 represents the transition from measurement to high-dose motor relearning. The patient's baseline data now drives precise device parameter selection, and the therapeutic dose escalates substantially. This is the week in which the neural substrate for recovery is most aggressively cultivated.

WEEK 2 TYPICAL THERAPEUTIC DOSE

- **AMADEO (Upper Limb):** Patients with moderate spasticity may receive CPMplus followed by assist-as-needed active therapy with EMG triggering guided finger movements per session.
- **DIEGO:** Sessions focused on gravity-compensated reaching in virtual environments.
- **PABLO:** Force-controlled grip tasks integrated with functional ADL simulation (cup grasp, key turn, page turn). Biofeedback thresholds are set just above Week 1 baseline values.
- **MYRO:** Dual-task sessions combining reaching with cognitive load, selective attention, spatial planning, and working memory challenges to train cognitive-motor integration.
- **D-WALL Elite:** Functional movement training with real-time avatar biofeedback; emphasis on correcting asymmetric weight bearing and pelvic drop.
- **SMART GRAVITY:** Gait sessions with body-weight offload, targeting reciprocal symmetry and cadence rather than distance.
- **TYMO / ProKin:** Progressive static-to-dynamic balance re-education with explicit visual Centre of Pressure feedback;
- **Neuromodulation (Selected Patients):** tDCS (2 mA) over M1 contralateral to the primary motor or pain region, immediately followed by robotic or FES-assisted therapy to exploit the window of heightened cortical excitability.
- **Mirror Therapy / GMI:** Sessions for chronic pain or severe hemiparesis cohorts, progressing through laterality, imagined movement, and mirror phases.
- **Psychology:** Two structured CBT/ACT sessions focused on pain neuroscience education, cognitive defusion, and pacing.

Daily fatigue is monitored using the Borg RPE scale, autonomic signs, and self-reported pain intensity. Dose is intentionally escalated only when the patient tolerates the previous day's load with post-session recovery .

Week 3 Consolidation, Load Progression, and Transfer of Training

Week 3 is the consolidation phase. Neural pathways established in Week 2 are now loaded with progressively greater demand, task complexity, and ecological validity. The emphasis shifts from isolated movement quality to integrated function, movements that look and feel like the real-world tasks the patient must perform at home and in the community.

WEEK 3 PROGRESSION STRATEGIES

- **DIEGO + VR ADL Scenarios:** Reaching tasks are embedded in immersive scenarios supermarket shelving, kitchen retrieval, dressing with gravity support gradually withdrawn.
- **AMADEO PABLO Transition:** Patients graduate from isolated finger robotics to unstructured object manipulation with PABLO sensors, testing whether Week 2 gains generalise to real-world objects.
- **MYRO Dual- and Triple-Task Loading:** Cognitive and motor demands are layered; for example, bilateral upper-limb task + verbal working memory + postural challenge on TYMO simultaneously.
- **SMART GRAVITY Weaning:** Body-weight offload is reduced by 5-10% per session. Gait speed and cadence targets are pushed into the pre-injury range where tolerated.
- **D-WALL Elite Functional Modules:** Step-ups, lunges, rotational tasks, and dynamic reach with continuous avatar feedback.
- **FES Integration:** Foot-drop FES during overground walking; upper-limb FES during grasp tasks for sensorimotor re-coupling.
- **Exercise Physiology:** Interval conditioning introduced with cardiovascular monitoring; the aim is to rebuild the metabolic reserve required to tolerate community-level activity.
- **Psychology:** Graded exposure, advanced cognitive behaviour therapy.

Midway through Week 3, a formal re-assessment is conducted using the same instruments administered during Week 1. This generates interim outcomes that are shared with the patient, family, and referrer, reinforcing motivation and enabling objective documentation for insurers and funders.

Week 4 Transition, Home Program, and Discharge Planning

Week 4 is explicitly designed to ensure the durability of gains beyond the clinic walls. Neuroplastic changes are use-dependent; without an ongoing stimulus, they regress. Week 4 therefore re-centres on the environment, routines, and relationships that will sustain the patient's recovery.

WEEK 4 TRANSITION ACTIVITIES

- **Home Program Engineering:** A structured, evidence-weighted home Program is written jointly by physiotherapy, occupational therapy, exercise physiology, and psychology. Each exercise specifies dose, frequency, progression, and self-monitoring.
- **Caregiver Training:** Family members and primary carers are brought into selected therapy sessions and trained in safe transfer, spasticity positioning, pacing enforcement, and recognition of red flags.
- **Final Comprehensive Reassessment:** All Week 1 instruments are repeated; change scores are quantified; a structured Outcomes Report is generated.
- **Community Handover:** Clinical summary, home Program, outcome data, and recommended ongoing supports are issued to the GP, community allied health providers, case manager, and funder.
- **Return-to-Role Planning:** Work, study, driving, parenting, and leisure roles are explicitly discussed; where applicable, vocational rehabilitation pathways are initiated.
- **Follow-Up Scheduling:** Booster reviews at 6 weeks, 3 months, and 6 months post-discharge are strongly recommended to verify maintenance and adjust the home Program.
- **Unique home device: The homing** portable system includes integrated movement tracking, heart rate monitoring, cloud-based data management, and customised rehabilitation pathways that enable clinicians to monitor progress and adjust care plans remotely.

Four-Week Summary Matrix

Dimension	Week 1 Â· Baseline	Week 2 Â· Acquisition	Week 3 Â· Consolidation	Week 4 Â· Translation
Focus	Precision measurement	High-dose skill building	Generalisation & dual-task	Home transfer & discharge
Therapeutic Dose	Moderate, tolerance-calibrated	High	High with load progression	Moderate, ecologically valid
Key Disciplines	All disciplines (assessment)	Physio, OT, Exercise Physiology, Pain specialist	OT, Psychology, Neuropsych, Pain specialist	OT, Social Work, Family
Measurement Events	Full baseline assessment	Mid-week PABLO / TYMO	Formal interim re-assessment	Full re-assessment + Outcomes Report

Patient Selection, Assessment and Outcomes

TheVIP-START Program is a highly intensive clinical intervention. It is not suitable for every individual at every stage of their recovery. A rigorous pre-admission interdisciplinary screening process is applied to determine suitability, safeguard medical safety, and ensure that each patient has the capacity to derive meaningful benefit from the Program.

Pre-Admission Screening Workflow

1. Referral received with medical history, imaging, and current therapy records.
2. Initial triage by the Rehabilitation Physician and Rehabilitation Nurse.
3. Multidisciplinary case review involving medical, psychology, and allied health leads to evaluate goal alignment and clinical feasibility.
4. Patient and family interview, ideally in person or by telehealth.
5. Finalisation of admission plan, baseline instrument schedule, technology screening (including contraindications for neuromodulation and VR), and consent.

Baseline Assessment

Comprehensive measurement is the foundation of theVIP-START Program. Instruments are selected to span the International Classification of Functioning, Disability and Health (ICF) domains: body structure and function, activity, and participation.

- A diminished **Glasgow Coma Scale (GCS)**
- Significant findings on **brain imaging** (CT or MRI)
- A period of **post-traumatic amnesia (PTA)**
- Ongoing evidence of a **permanent neurological or functional impairment**
- Requirement for ongoing treatment, rehabilitation, care, or support services

CORE MEASUREMENT INSTRUMENTS

- **Global function:** Functional Independence Measure (FIM), MPAI-4
- **Goal setting:** Canadian Occupational Performance Measure (COPM)
- **Mood and trauma:** PHQ-9, GAD-7, PCL-5, Depression Anxiety Stress Scales (DASS-21)
- **Pain:** Numeric Rating Scale, Pain Catastrophising Scale, Tampa Scale for Kinesiophobia, Chronic Pain Acceptance Questionnaire
- **Mobility:** Berg Balance Scale, 10-Metre Walk Test, 6-Minute Walk Test, Timed Up and Go
- **Cognition:** MoCA, targeted neuropsychological testing as clinically indicated
- **Device-derived metrics:** PABLO force metrics, TYMO posturography, D-WALL kinematics, AMADEO digit-level ROM and EMG

Goal Setting

Goals are elicited collaboratively using COPM and structured interviews, then formalised as SMART (specific, measurable, achievable, relevant, time-bound) objectives in the shared electronic care plan. Goals are always anchored in participation: return to driving, return to parenting a young child, return to paid work, return to sport. Impairment-level targets serve these participation goals rather than standing alone.

Expected Outcome Trajectories

Outcomes are framed realistically and ethically. ARC does not promise cures. We promise the optimisation of the nervous system's capacity to adapt and the maximisation of functional independence within that capacity.

- **Short term (Weeks 1-2):** improved postural awareness, reduced fear-avoidance, familiarity with complex movements, reduction in resting tone, and robust baseline data.
- **Medium term (End of Week 4):** quantifiable gains in joint range of motion, force control, gait velocity, dynamic balance symmetry, reduced reliance on mobility aids, and acquisition of durable pain self-management strategies.
- **Long term (Post-discharge):** enhanced community and social participation, successful return to vocational or avocational pursuits, long-term neuroplastic adaptation maintained through home Programs, and durable self-efficacy over the physical condition.

Outcome Reporting

At discharge, every patient receives a comprehensive Outcomes Report comparing Week 1 baseline with Week 4 reassessment across all instruments. Copies are issued, with consent, to the referring clinician, GP, funder or insurer, case manager, and community therapy providers. Outcome dashboards support transparent accounting to the NDIS, Department of Veterans' Affairs, workers' compensation schemes, and private health funds.

Chronic Pain Management (Neuroplasticity-Based)

Chronic pain is a pervasive and treatment-resistant comorbidity in populations with acquired brain injury, spinal cord injury, and complex musculoskeletal trauma. In theVIP-START Program, pain is understood as a complex, emergent property of the central nervous system, a state of maladaptive neuroplasticity requiring active, targeted rehabilitation rather than pharmacological suppression alone.

Modern Pain Science and Neuroplasticity in Chronic Pain

The traditional biomedical model of pain, viewing it as a direct correlate of tissue damage, fails to account for chronic pain states in which tissue healing has occurred but pain persists. Contemporary neuroscience understands chronic pain as an expression of maladaptive neuroplasticity. Central sensitisation amplifies neural signalling within the dorsal horn of the spinal cord and ascending pathways [38]. Further, chronic pain is accompanied by “smudging” of primary somatosensory (S1) and primary motor (M1) cortical representations: the brain loses its precise topographical map of the affected body part, and this ambiguity is interpreted as a threat, generating pain as a protective output [36, 37, 41].

Neuroimaging reveals that long-standing pain reorganises the distributed “pain neuromatrix,” shifting activity from sensory-discriminative regions toward limbic and prefrontal circuits [36, 37]. The ICD-11 formally recognises nociplastic pain as a third mechanistic category alongside nociceptive and neuropathic pain [39, 42]. TheVIP-START Program is designed to drive “positive” neuroplasticity, resharpening cortical maps, restoring descending inhibition, and down-regulating the central threat response.

Graded Motor Imagery (GMI)

GMI is a sequential, evidence-based protocol designed to activate motor networks without provoking pain. Moseley’s randomised controlled trials demonstrated clinically meaningful reductions in pain and disability in CRPS, sustained at six-month follow-up [28, 29]. Systematic reviews support the sequential structure [9, 43].

Mirror Therapy

Introduced by Ramachandran for phantom limb pain, mirror therapy exploits and proprioceptive integration. The Cochrane review of mirror therapy in stroke (Thieme et al., 2018) reported moderate-quality evidence of improvement in motor function, impairment, ADLs, and pain [30]. WithinVIP-START, mirror therapy is embedded alongside PABLO and AMADEO so that the visual illusion is reinforced by tactile-kinaesthetic congruence, further sharpening cortical maps.

Virtual Reality Based Pain Treatment

Immersive VR acts as a profound, multisensory attentional distractor, reducing the cognitive bandwidth available for nociceptive processing [8, 46]. Crucially, VR also enables safe, gamified graded exposure to feared movements. WithinVIP-START, VR is operationalised through DIEGO and MYRO platforms, plus dedicated VR headset sessions supervised by OT. VR is contraindicated or cautioned in severe vestibular dysfunction, active migraine, photosensitive epilepsy, and cybersickness-prone patients.

Transcranial Direct Current Stimulation (tDCS) and Repetitive rTMS

Meta-analyses indicate small-to-moderate analgesic effects of tDCS in chronic neuropathic pain, fibromyalgia, and SCI pain, particularly when M1 is targeted and paired with physical or behavioural rehabilitation [11, 44]. rTMS of M1 at high frequency carries Level A evidence for chronic neuropathic pain per international consensus guidelines [45]. Both modalities are used selectively at ARC, with rigorous screening and rehabilitation pairing.

Functional Electrical Stimulation (FES)

FES generates functional movement and provides massive ascending proprioceptive input, helping to “sharpen” smudged cortical maps [13, 80]. WithinVIP-START, FES is interleaved with robotic and functional training foot drop during overground walking, upper-limb FES during grasp so that evoked plasticity is channelled into purposeful, ecologically valid movement.

Biofeedback

Biofeedback addresses aberrant muscle activation and autonomic hyperarousal simultaneously. TheVIP-START Program deploys surface EMG biofeedback via AMADEO and PABLO, force biofeedback via PABLO and MYRO, Centre-of-Pressure biofeedback via TYMO/ProKin/D-WALL Elite, heart rate variability (HRV) biofeedback through psychology [47], and, where clinically appropriate, EEG neurofeedback [48].

Cognitive-Behavioural Approaches to Pain

Pain Neuroscience Education (PNE), CBT, ACT, and Mindfulness-Based Stress Reduction (MBSR) form the psychological backbone of chronic pain care. Systematic reviews support PNE paired with active rehabilitation [49, 50], ACT for psychological flexibility and disability reduction [51], and MBSR for pain, mood, and quality of life [52]. Together, these interventions target pain catastrophizing among the strongest predictors of long-term disability and restore the patient’s sense of agency.

The Integrated VIP-START Pain Pathway

ACROSS FOUR WEEKS

- **Week 1 Foundation:** comprehensive pain assessment; Pain Neuroscience Education; laterality training commences; HRV biofeedback initiated.
- **Week 2 Activation:** GMI progresses through explicit motor imagery; tDCS priming in selected cases paired with robotics; VR distraction deployed for movements rated 5/10; FES introduced; CBT pacing.
- **Week 3 Consolidation:** mirror therapy integrated with PABLO, AMADEO, and DIEGO; graded exposure to feared functional activities; ACT values-based committed action; rTMS for selected refractory cases; community-simulated tasks in VR.
- **Week 4 Translation:** home-based pain self-management plan daily mirror therapy, laterality app use, HRV breathing, pacing schedules, and values-based activity engagement; relapse prevention and flare-up protocol documented.

Clinical Reasoning Matrix for Pain Presentations

Presentation	Primary Mechanism	Targeted Interventions	Expected Contribution
CRPS	Autonomic dysregulation, cortical smudging, central sensitisation	GMI, mirror therapy, VR distraction, autonomic regulation	S1/M1 resharpening, reduced allodynia, restored pain-free ROM
SCI Neuropathic Pain	Loss of descending inhibition, ectopic firing, sensorimotor mismatch	tDCS, VR, FES, CBT	Pain matrix modulation, reduced burning/shooting, resilience
Post Shoulder Injury Pain	Subluxation, spasticity, altered biomechanics, learned non-use	DIEGO, AMADEO, FES to deltoid	Joint congruency, reduced impingement, safe active-assisted motion
Mixed Nociplastic Pain	Widespread sensitisation, fear-avoidance, deconditioning	SMART GRAVITY, Balance Trunk, pacing via psychology	Graded desensitisation, metabolic recovery, fractured fear loops

Evidence Base

The clinical architecture of the VIP-START Program is heavily grounded in contemporary neurorehabilitation and pain science literature. The following condensed review summarises the evidence underpinning each element of the Program.

Multidisciplinary Rehabilitation in Moderate-to-Severe TBI

The landmark Cochrane review by Turner-Stokes and colleagues concluded that more intensive multidisciplinary rehabilitation produces superior functional outcomes in working-age adults with acquired brain injury than less intensive alternatives, with benefits that persist long after active treatment ends [55, 56]. Sarajuuri and colleagues (2005) reported that 89% of patients completing a comprehensive neuropsychological rehabilitation Program (n=39) were productively engaged in work or study at two years, compared with 55% in controls [57]. Semlyen and Andelic found that intensive interdisciplinary Programs produce superior gains on standardised disability measures and better long-term community integration [58, 59]. Cicerone's review of cognitive rehabilitation literature supports the same conclusion [60].

Intensive 4-Week Program Outcomes

A 2020 Frontiers in Neurology study of a 3-week intensive outpatient Program for service members with persistent post-concussion symptoms found that improvements correlated tightly with baseline severity: anxiety (GAD-7 r=0.59), depression (PHQ-8 r=0.56), and post-traumatic stress (PCL-M r=0.52), indicating that higher symptom burden predicts greater benefit from intensive structured Programs [61]. Malec's analysis of MPAI-4 outcomes across more than 3,000 post-acute brain injury rehabilitation patients demonstrated robust, reliable, and clinically meaningful improvements in ability, adjustment, and participation [62, 63].

Robotics in Neurorehabilitation

Cochrane reviews support robotic upper-limb training [4] and electromechanical-assisted walking training [24] after stroke. Exoskeleton technology including the Ekso GT has produced meaningful functional gains in SCI populations, with published cohorts reporting mean FIM change of approximately 28.5 ± 13.1 points following intensive exoskeleton-assisted rehabilitation [64, 65]. Device-specific evidence supports DIEGO and AMADEO for motor and spasticity outcomes [66-68], and Lokomat for sub-acute stroke and SCI gait [22].

Virtual Reality and Gamification

The Cochrane review of VR in stroke supports benefit when VR augments rather than replaces conventional therapy [7]. Aida and colleagues' systematic review of VR in TBI rehabilitation supports cognitive, motor, and behavioural benefits [69]. Rahmani-Katigari's 2023 BMC Psychiatry systematic review found that gamified interventions improve adherence, engagement, and outcomes in mental health and rehabilitation [74]. Kuil's earlier work supports gamified cognitive tasks for ABI rehabilitation [75].

Neuroplasticity Mechanisms

Kleim and Jones' 2008 articulation of ten principles of experience-dependent plasticity remains foundational [1]. Cellular and molecular mechanisms include LTP/LTD, dendritic remodelling, BDNF upregulation, and exercise-induced neurotrophic cascades [15, 76, 77]. Experience-dependent plasticity is bidirectional; theVIP-START Program is designed to tilt the balance toward adaptive rather than maladaptive plasticity [20].

Non-Invasive Brain Stimulation

The Cochrane review of tDCS for post-stroke activities of daily living concluded that tDCS paired with motor training produces superior outcomes to motor training alone [79]. For rTMS, the European expert guidelines assign Level A evidence for high-frequency M1 stimulation in chronic neuropathic pain [45]. Both modalities are integrated intoVIP-START as rehabilitation primers, not stand-alone therapies.

Functional Electrical Stimulation

The Marquez-Chin and Popovic systematic review of FES in stroke and SCI concluded that FES produces significant improvements in motor function, muscle strength, and spasticity when combined with functional task training [80].

PTSD, Mental Health, and Psychological Comorbidities

The American Psychological Association's clinical practice guidelines strongly recommend trauma-focused psychotherapies for PTSD [82], and integrated models adapted for TBI cohorts demonstrate feasibility and benefit [83, 84]. Interdisciplinary chronic pain rehabilitation incorporating CBT remains the gold standard [12, 32].

Relationships and Intimacy

The INTIMASY-TBI clinical practice guideline provides the first internationally endorsed framework for assessing and addressing intimacy and sexuality after TBI, and informs the ARC sexual health counselling pathway [85].

Post-Traumatic Seizure Management

Evidence-based reviews support prophylactic anti-seizure medication in the first week after severe TBI to reduce early seizure risk, with routine long-term prophylaxis not recommended [86]. Technology protocols at ARC (tDCS, TMS, immersive VR, specific FES applications) are explicitly modified in patients with active or unstable epilepsy.

Cost-Effectiveness

Turner-Stokes and colleagues have repeatedly shown that intensive specialist rehabilitation produces downstream care savings that substantially exceed the upfront Program expense, with greater savings for the most severely disabled patients [55, 87]. The VIP-START Program's time-limited, measurable structure is explicitly designed to be reportable and accountable to funders.

Synthesis

No single intervention within theVIP-START Program is sufficient on its own. The strength of the model lies in its deliberate, evidence-aligned integration: high-dose task-specific robotics for motor relearning; immersive VR and gamification for engagement; neuromodulation for cortical priming; FES and biofeedback for sensorimotor re-coupling; multidisciplinary psychology for pain, mood, and trauma; exercise physiology for the physiological engine of recovery; and rigorous measurement for accountability and adaptation. This is the evidence-based rationale behind every day of the four-week Program.

Technology and Equipment Suite

The VIP-START Program is defined by our team and their experience. ARC has invested in the most advanced rehabilitation technology currently available in Queensland so that our clinicians can deliver the doses, feedback, and objectivity that experience-dependent neuroplasticity demands.

ARC's Seven Pillars of Innovation

ROBOTICS

Advanced upper-limb and hand robotics provide precise, repeatable, assist-as-needed movement at doses impossible to achieve manually.

VIRTUAL REALITY

Immersive environments deliver salience, motivation, pain distraction, and graded exposure to feared movements.

GAMIFICATION

Game-based tasks recruit dopaminergic reward networks, sustain engagement, and enable the high repetition counts neuroplasticity requires.

ARTIFICIAL INTELLIGENCE

Assist-as-needed algorithms, adaptive difficulty, and the HOMING cloud analytics personalise therapy in real time.

FUNCTIONAL ELECTRICAL STIMULATION

Targeted electrical currents activate paretic muscle, generate functional movement, and restore sensorimotor coupling.

EXOSKELETONS & BODY-WEIGHT SUPPORT

Dynamic body-weight-supported systems safely enable early reciprocal gait practice in patients who cannot yet stand independently.

NEUROPLASTICITY-DRIVEN CARE

The unifying principle beneath every ARC pillar. All technology is deployed in the service of experience- dependent cortical and spinal reorganisation, guided by Kleim and Jones' principles and decades of rehabilitation evidence.

Tyromotion Suite

Austrian-engineered upper-limb and balance rehabilitation technology that underpins motor and cognitive retraining at ARC.

PABLO HAND AND FINGER REHABILITATION WITH BIOFEEDBACK

A multifunctional rehabilitation device with comprehensive accessories that enhances classical therapy with biofeedback, objective assessment, and gamification. PABLO quantifies multiple grip types (cylindrical, pinch, three-point, lateral, interdigital), wrist ROM across three axes, and can extend therapy to elbow and shoulder.

Clinical applications: grip force training, wrist kinematics, functional ADL practice, trunk and lower-limb extensions.

Patients who benefit: upper motor neuron lesions, stroke, brain injury, SCI with impaired grip coordination, and chronic pain cohorts using bilateral tasks during GMI progression.

AMADEO ROBOTIC FINGER-HAND THERAPY

An advanced robotic system engineered specifically for finger and hand rehabilitation, offering passive, assistive, and active therapy modes with EMG integration. AMADEO enables hundreds of robot-assisted grasping movements in a single session and includes dedicated protocols for spasticity management.

Clinical applications: severe upper-limb paresis, spasticity management, EMG-triggered active therapy, paediatric and adult rehabilitation.

Patients who benefit: severe upper-limb impairment with significant spasticity or minimal active digit movement.

MYRO UPPER-LIMB FUNCTIONAL THERAPY WITH REAL OBJECTS

A sensor-based surface enabling task-oriented rehabilitation with real objects, blending motor therapy and cognitive rehabilitation. MYRO supports intuitive touch, force application, and object manipulation in sitting, standing, wheelchair, and bedside configurations.

Clinical applications: cognitive-motor interference training, graphomotor skills, selective attention, bilateral coordination.

Patients who benefit: TBI and stroke patients requiring concurrent cognitive and motor rehabilitation.

YMO BALANCE TRAINING AND FALL PREVENTION

A versatile stabilometric measurement and therapy system. TYMO quantifies Centre of Pressure (COP), body sway, and load distribution through standardised posturography, and supports dynamic balance training via therapeutic games.

Clinical applications: posturography, dynamic balance training, weight-shifting, and core stability development.

Patients who benefit: ataxia, vestibulocerebellar dysfunction, hemiparesis, and high fall risk.

DIEGO ROBOTIC ARM-SHOULDER THERAPY (BILATERAL)

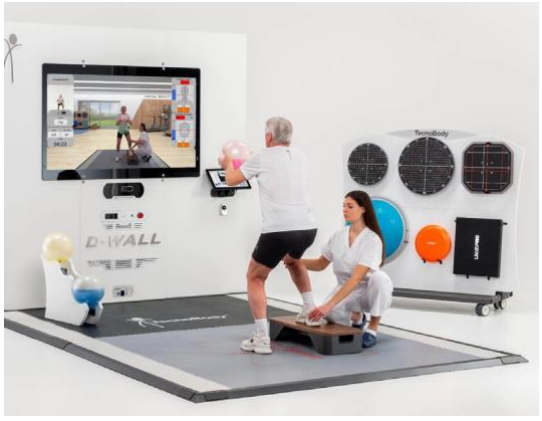
An overhead robotic system for bilateral or unilateral arm and shoulder rehabilitation in three-dimensional space. DIEGO uses intelligent weight compensation to allow natural movement ranges and integrates VR environments to increase task salience.

Clinical applications: gravity-eliminated ADL practice, ROM enhancement, functional reaching tasks.

Patients who benefit: patients with profound proximal arm weakness struggling against gravity.

Tecnobody Suite

Italian-engineered movement analysis and functional training platform powering ARC's posturography, gait, and biomechanical retraining.



D-WALL ELITE MOVEMENT ANALYSIS AND TRAINING

A digital mirror combining a 3D infrared camera and force platform to recognise up to sixteen body articulations in real time. D-WALL Elite delivers live avatar biofeedback for functional movement training, balance re-education, and rehabilitation assessment.

Clinical applications: kinematic screening, avatar-guided functional training, gait symmetry, pelvic drop correction..

Patients who benefit: hemiparesis, chronic musculoskeletal compensatory patterns, and post-SCI movement re-education.

PROKIN PROPRIOCEPTIVE AND STABILOMETRIC ASSESSMENT

A complete system for proprioceptive evaluation and training through detailed test reports and training modules. ProKin supports static and dynamic instability modes for ankle and knee joint position sense training and lower-limb sensorimotor retraining.

Clinical applications: proprioceptive assessment, ankle-knee rehabilitation, injury prevention.

Patients who benefit: post-SCI, post-stroke lower-limb dysfunction, and orthopaedic neurological overlap.

BALANCE TRUNK LUMBAR AND TRUNK STABILISATION

A seated gamified platform that quantifies pelvic tilt awareness and trunk control, providing biofeedback for lumbar stabilisation. Particularly valuable for patients in early recovery who cannot yet tolerate standing rehabilitation.

Clinical applications: seated trunk control, pelvic awareness, core stabilisation.

Patients who benefit: SCI, early-stage TBI, post-surgical patients, and those with chronic low back pain.

SMART GRAVITY DYNAMIC BODY-WEIGHT-RELIEF SYSTEM

A dynamic, precisely controlled body-weight support system used with Walker View treadmill and overground for reciprocal gait practice. Patented Automatic Speed Control (SCX) allows the belt to respond to the patient's intent, enabling instinctive transitions from walk to run.

Clinical applications: early gait practice, reciprocal symmetry retraining, progressive load weaning.

Patients who benefit: incomplete SCI, chronic stroke, post-TBI gait disorders, and deconditioned patients requiring safe gait re-initiation.

HOMING INTEGRATED REHABILITATION DATA PLATFORM

The Tecnobody cloud platform that unifies data across every Tecnobody device, providing a longitudinal record of each patient's objective metrics. HOMING powers weekly outcome review, insurer reporting, and evidence-based Program refinement.

Clinical applications: outcome tracking, team coordination, insurer and funder reporting.

Patients who benefit: every patient admitted to theVIP-START Program.

Contact and Enrolment

To discuss a referral, assess suitability, or arrange a clinical tour of ARC, please contact our intake team. Every prospective patient is individually assessed, and an interdisciplinary screening process determines clinical suitability before admission.

ACCELERATED RECOVERY CENTRE

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References

1. Kleim JA, Jones TA. Principles of experience-dependent neural plasticity: implications for rehabilitation after brain damage. J Speech Lang Hear Res. 2008;51(1):S225-S239.
2. Lang CE, MacDonald JR, Reisman DS, et al. Observation of amounts of movement practice provided during stroke rehabilitation. Arch Phys Med Rehabil. 2009;90(12):1692-1698.
3. Lohse KR, Lang CE, Boyd LA. Is more better? Using metadata to explore dose response relationships in stroke rehabilitation. Stroke. 2014;45(7):2053-2058.
4. Mehrholz J, Pohl M, Platz T, Kugler J, Elsner B. Electromechanical and robot-assisted arm training. Cochrane Database Syst Rev. 2018;9:CD006876.
5. Dobkin BH, Apple D, Barbeau H, et al. Weight-supported treadmill vs over-ground training for walking after acute incomplete SCI. Neurology. 2006;66(3):484-493.
6. Zijlstra A, Mancini M, Chiari L, Zijlstra W. Biofeedback for training balance and mobility. J Neuroeng Rehabil. 2010;7:58.
7. Laver KE, Lange B, George S, et al. Virtual reality for stroke rehabilitation. Cochrane Database Syst Rev. 2017;11:CD008349.
8. Li A, Monta, Chen VJ, Gold JI. Virtual reality and pain management. Pain Manag. 2011;1(2):147-157.
9. Bowering KJ, O'Connell NE, Tabor A, et al. Effects of graded motor imagery on chronic pain: systematic review and meta-analysis. J Pain. 2013;14(1):3-13.
10. Moseley GL, Flor H. Targeting cortical representations in the treatment of chronic pain. Neurorehabil Neural Repair. 2012;26(6):646-652.
11. O'Connell NE, Marston L, Spencer S, et al. Non-invasive brain stimulation techniques for chronic pain. Cochrane Database Syst Rev. 2018;4:CD008208.
12. Kamper SJ, Apeldoorn AT, Chiarotto A, et al. Multidisciplinary biopsychosocial rehabilitation for chronic low back pain. BMJ. 2015;350-444.
13. Daly JJ, Wolpaw JR. Magnetic and electrical stimulation in rehabilitation of motor function. Muscle Nerve. 2008;38(4):1481-1492.
14. Nijs J, van Wilgen CP, Van Oosterwijck J, et al. How to explain central sensitisation to patients. Man Ther. 2011;16(5):413-418.
15. Krakauer JW, Carmichael ST, Wolf SL, et al. Predicting recovery and optimising rehabilitation after stroke. Neurorehabil Neural Repair. 2012;26(8):923-931.
16. Winstein CJ, Stein J, Arena R, et al. Guidelines for adult stroke rehabilitation and recovery. Stroke. 2016;47(6):98-169.
17. Pollock A, Baer G, Campbell P, et al. Physical rehabilitation approaches for recovery of function post-stroke. Cochrane Database Syst Rev. 2014;4:CD001920.
18. Veerbeek JM, van Wegen E, van Peppen R, et al. What is the evidence for physical therapy poststroke? PLoS One. 2014;9(2):87987.
19. Carey LM, Matyas TA, Baum C. Effects of somatosensory impairment on participation after stroke. Arch Phys Med Rehabil. 1993;74(8):877-884.
20. Levin MF, Kleim JA, Wolf SL. What do motor "recovery" and "compensation" mean? Neurorehabil Neural Repair. 2009;23(4):313-319.
21. Dobkin BH. Rehabilitation after stroke. N Engl J Med. 2005;352(16):1677-1684.
22. Morone G, Paolucci S, Cherubini A, et al. Robot-assisted gait training for stroke patients. Neuropsychiatr Dis Treat. 2017;13:1303-1311.
23. Lo AC, Guarino PD, Richards LG, et al. Robot-assisted therapy for long-term upper-limb impairment after stroke. N Engl J Med. 2010;362(19):1772-1783.
24. Mehrholz J, Thomas S, Werner C, et al. Electromechanical-assisted training for walking after stroke. Cochrane Database Syst Rev. 2020;10:CD006185.
25. Simpson LA, Eng JJ, Hsieh JTC, Wolfe DL. Health and life priorities of individuals with SCI. J Neurotrauma. 2012;29(8):1548-1555.
26. Harvey LA. Physiotherapy rehabilitation for people with spinal cord injuries. J Physiother. 2016;62(1):4-11.
27. Benito-Penalva J, Edwards DJ, Opisso E, et al. Gait training in SCI using electromechanical systems. Arch Phys Med Rehabil. 2012;93(3):404-412.
28. Moseley GL. Graded motor imagery is effective for long-standing CRPS: a randomised controlled trial. Pain. 2004;108(12):192-198.
29. Moseley GL. Graded motor imagery for pathologic pain: a randomised controlled trial. Neurology. 2006;67(12):2129-2134.
30. Thieme H, Morkisch N, Mehrholz J, et al. Mirror therapy for improving motor function after stroke. Cochrane Database Syst Rev. 2018;7:CD008449.
31. Flor H. Phantom-limb pain: characteristics, causes, and treatment. Lancet Neurol. 2002;1(3):182-189.
32. Gatchel RJ, McGeary DD, McGeary CA, Lippe B. Interdisciplinary chronic pain management. Am Psychol. 2014;69(2):119-130.
33. Vlaeyen JWS, Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain. Pain. 2000;85(3):317-332.
34. Turk DC, Wilson HD, Cahana A. Treatment of chronic non-cancer pain. Lancet. 2011;377(9784):2226-2235.
35. Nicholas MK, Linton SJ, Watson PJ, Main CJ. Early identification and management of psychological risk factors in low back pain. Phys Ther. 2011;91(5):737-753.
36. Apkarian AV, Baliki MN, Geha PY. Towards a theory of chronic pain. Prog Neurobiol. 2009;87(2):81-97.
37. Baliki MN, Apkarian AV. Nociception, pain, negative moods, and behaviour selection. Neuron. 2015;87(3):474-491.
38. Woolf CJ. Central sensitisation: implications for diagnosis and treatment of pain. Pain. 2011;152(3 Suppl):S2-S15.
39. Treede RD, Rief W, Barke A, et al. Chronic pain as a symptom or a disease: IASP ICD-11 classification. Pain. 2019;160(1):19-27.
40. Jensen MP, Turk DC. Contributions of psychology to understanding and treatment of chronic pain. Am Psychol. 2014;69(2):105-118.
41. Seminowicz DA, Moayedi M. The dorsolateral prefrontal cortex in acute and chronic pain. J Pain. 2017;18(9):1027-1035.
42. Kosek E, Cohen M, Baron R, et al. Do we need a third mechanistic descriptor for chronic pain states? Pain. 2016;157(7):1382-1386.
43. Fregni F, Gimenes R, Valle AC, et al. Randomised sham-controlled tDCS for fibromyalgia pain. Arthritis Rheum. 2006;54(12):3988-3998.
44. Lefaucheur JP, Aleman A, Baeken C, et al. Evidence-based guidelines on therapeutic rTMS: update (2014â€“2018). Clin Neurophysiol. 2020;131(2):474-528.
45. Hoffman HG, Meyer WJ III, Ramirez M, et al. Feasibility of VR goggles for adjunctive pain control in paediatric burn patients. Cyberpsychol Behav Soc Netw. 2014;17(6):397-401.

References

46. Lehrer PM, Gevirtz R. Heart rate variability biofeedback: how and why does it work? Front Psychol. 2014;5:756.
47. Hassan MA, Fraser M, Conway BA, et al. Neurofeedback for central neuropathic pain in paraplegia: pilot study. BMC Neurol. 2015;15:200.
48. Louw A, Diener I, Butler DS, Puentedura EJ. Effect of neuroscience education on pain and disability. Arch Phys Med Rehabil. 2011;92(12):2041-2056.
49. Wood L, Hendrick PA. Pain neuroscience education for chronic low back pain: systematic review. Eur J Pain. 2019;23(2):234-249.
50. Hughes LS, Clark J, Colclough JA, et al. ACT for chronic pain: systematic review and meta-analyses. Clin J Pain. 2017;33(6):552-568.
51. Hilton L, Hempel S, Ewing BA, et al. Mindfulness meditation for chronic pain: systematic review and meta-analysis. Ann Behav Med. 2017;51(2):199-213.
52. Wilson L, Stewart W, Dams-O'Connor K, et al. Chronic and evolving neurological consequences of TBI. Lancet Neurol. 2017;16(10):813-825.
53. Maas AIR, Menon DK, Adelson PD, et al. Traumatic brain injury: integrated approaches. Lancet Neurol. 2017;16(12):987-1048.
54. Turner-Stokes L, Pick A, Nair A, Disler PB, Wade DT. Multidisciplinary rehabilitation for acquired brain injury in adults of working age. Cochrane Database Syst Rev. 2015;(12):CD004170.
55. Turner-Stokes L, Bavikatte G, Williams H, et al. Cost-efficiency of specialist inpatient rehabilitation. BMJ Open. 2016;6(2)
56. Sarajuuri JM, Kaipio ML, Koskinen SK, et al. Outcome of comprehensive neurorehabilitation for TBI. Arch Phys Med Rehabil. 2005;86(12):2296-2302.
57. Semlyen JK, Summers SJ, Barnes MP. TBI: efficacy of multidisciplinary rehabilitation. Arch Phys Med Rehabil. 1998;79(6):678-683.
58. Andelic N, Bautz-Holter E, Ronning P, et al. Does early onset and continuous chain of rehabilitation improve long-term outcome after severe TBI? J Neurotrauma. 2012;29(1):66-74.
59. Cicerone KD, Goldin Y, Ganci K, et al. Evidence-based cognitive rehabilitation (2009-2014). Arch Phys Med Rehabil. 2019;100(8):1515-1533.
60. Bailie JM, Remigio-Baker RA, Cole WR, et al. Profile analysis of outcomes of service members in a 3-week intensive outpatient Program. Front Neurol. 2020;11:580182.
61. Malec JF, Kean J. Post-inpatient brain injury rehabilitation outcomes. J Neurotrauma. 2016;33(14):1371-1379.
62. Zasler ND, Katz DI, Zafonte RD, et al. Brain Injury Medicine. 3rd ed. Demos Medical; 2022.
63. Esquenazi A, Talaty M, Packel A, Saulino M. ReWalk powered exoskeleton to restore ambulatory function in thoracic-level motor-complete SCI. Am J Phys Med Rehabil. 2012;91(11):911-921.
64. Tefertiller C, Hays K, Jones J, et al. Initial outcomes from a multicentre study utilising the Ekso exoskeleton in SCI. Top Spinal Cord Inj Rehabil. 2018;24(1):78-85.
65. Bartolo M, De Nunzio AM, Sebastiano F, et al. Arm weight-support training in chronic stroke. Clin Rehabil. 2014;28(8):770-777.
66. Sale P, Lombardi V, Franceschini M. Hand robotics rehabilitation in hemiparesis. Stroke Res Treat. 2012;2012:820931.
67. Aida J, Chau B, Dunn J. Immersive VR in TBI rehabilitation: a literature review. NeuroRehabilitation. 2018;42(4):441-448.
68. Maggio MG, Cuzzola MF, Latella D, et al. How may patients with MS benefit from VR combined with cognitive training? Brain Sci. 2022;12(3):357.
69. Saposnik G, Cohen LG, Mamdani M, et al. Efficacy and safety of non-immersive VR exercising in stroke rehabilitation (EVREST). Lancet Neurol. 2016;15(10):1019-1027.
70. Kwakkel G, van Wegen EEH, Burridge JH, et al. Standardised measurement of upper-limb movement after stroke. Neurorehabil Neural Repair. 2019;33(11):951-958.
71. Lin C, Kuo L, Hsu T, et al. Artificial intelligence applications in neurorehabilitation: a scoping review. J Clin Med. 2023;12(9):3139.
72. Rahmani-Katigari M, Mohammadian F, Shahmoradi L. Efficiency of gamification in enhancing treatment adherence in mental health: systematic review. BMC Psychiatry. 2023;23(1):856.
73. Kuil MNA, Visser-Meily JMA, Evers AWM, Van der Ham IJM. Usability of a serious game in cognitive rehabilitation. Front Psychol. 2018;9:846.
74. Cotman CW, Berchtold NC, Christie LA. Exercise builds brain health. Trends Neurosci. 2007;30(9):464-472.
75. Nudo RJ. Recovery after brain injury: mechanisms and principles. Front Hum Neurosci. 2013;7:887.
76. Biasiucci A, Leeb R, Iturrate I, et al. Brain-actuated FES elicits lasting arm motor recovery after stroke. Nat Commun. 2018;9(1):2421.
77. Elsner B, Kugler J, Pohl M, Mehrholz J. tDCS for improving ADLs and functioning after stroke. Cochrane Database Syst Rev. 2020;11:CD009645.
78. Marquez-Chin C, Popovic MR. FES therapy for restoration of motor function after SCI and stroke: a review. Biomed Eng Online. 2020;19(1):34.
79. Porciuncula F, Roto AV, Kumar D, et al. Wearable movement sensors for rehabilitation. PM R. 2018;10(9 Suppl 2):S220-S232. American Psychological Association. Clinical Practice Guideline for the Treatment of PTSD in Adults. Washington, DC: APA; 2017.
80. Wolf EJ, Spiller TR, Martin EM, et al. Treatment considerations for co-occurring PTSD and TBI. Society for the Advancement of Psychotherapy; 2020.
81. Wolf GK, Kretzmer T, Crawford E, et al. Prolonged exposure therapy with veterans and active duty personnel with PTSD and TBI. J Trauma Stress. 2015;28(4):339-347.
82. Moreno A, Gan C, Zasler N, et al. INTIMASY-TBI Guideline: optimising sexual wellbeing after TBI. Arch Phys Med Rehabil. 2024;105(12):2209-2220.
83. Temkin NR. Preventing and treating posttraumatic seizures: the human experience. Epilepsia. 2009;50(Suppl 2):10-13.
84. Turner-Stokes L, Williams H, Bill A, et al. Cost-efficiency of specialist inpatient rehabilitation for working-age adults with complex neurological disabilities. BMJ Open. 2016;6(2):e010238.