

TITLE

Embedding Telerehabilitation in Practice: Adapting NeuroRehabilitation OnLine (NROL) for a New Context Through Co-Production and Implementation Science Knowledge.

RUNNING HEAD

Adapting NROL to Embed Telerehabilitation in Practice

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TITLE

Embedding Telerehabilitation in Practice: Adapting NeuroRehabilitation OnLine (NROL) for a New Context Through Co-Production and Implementation Science Knowledge.

ABSTRACT

Background

Delivering recommended intensity of neurorehabilitation remains a challenge, with telerehabilitation offering one solution. NeuroRehabilitation OnLine (NROL) is a multidisciplinary, group-based telerehabilitation model embedded within one region in England, showing promise and alignment with healthcare strategic priorities. The importance of scaling successful evidence-informed practices is recognised, however careful adaptation is required to ensure contextual fit and sustainability. This study describes the adaptation of NROL for implementation in a new context.

Methods

The four-step ADAPT guidance was applied with previously identified implementation strategies to guide the adaptation of NROL from Region 1 to Region 2. Adaptation activities were co-produced. Contextual factors were detailed using the Consolidated Framework for Implementation Research and Intervention Sustainability Assessment Tool. The adapted innovation was described using the TIDieR-Rehab checklist.

Results

NROL was successfully adapted for Region 2. Step 1 confirmed strategic fit but identified barriers including workforce, infrastructure and resource. Led by an adaptation team and supported by a learning collaborative, Step 2 responded to barriers, retaining core components while tailoring role configuration and materials. Step 3 demonstrated feasibility and acceptability through piloting and phased integration, and improved fit within service pathways. Step 4 focused on sustainment, supported by training, stakeholder engagement, and reporting.

Discussion

This study offers a transferable approach for scale-up, providing an example of context-sensitive adaptation to a new region, demonstrating how frameworks and co-production can support the adaptation of telerehabilitation models. This example has potential wider use for researchers and implementers tasked with delivering impact, though highlights the effort and resource needed.

PLAIN LANGUAGE SUMMARY

Stroke and neurological rehabilitation services often struggle to provide enough therapy due to staffing and system challenges. Digital delivery of rehabilitation offers one solution.

NeuroRehabilitation OnLine (NROL) is a programme that offers live, group therapy and peer-support remotely for people recovering neurological conditions. It has been delivered within one region of England, showing promise and alignment with healthcare priorities. The importance of spreading successful, evidenced practices is recognised, but requires careful consideration to ensure they fit well and can be continued in the new location. This study explains how NROL was adapted for use in a second region.

The four-step process called the ADAPT guidance was used with previously identified practical strategies to guide changes to NROL for Region 2. Relevant staff from both regions worked together to ensure the programme met local needs. Evidenced tools were used to understand what made the new region different and to describe the adapted programme clearly.

NROL was successfully adapted for Region 2. Step 1 confirmed NROL alignment with healthcare priorities but highlighted challenges including limited staffing and resource. Led by a small team, Step 2 responded to challenges. The core parts of NROL were kept the same, like live group therapy and technology support, but changes were made to the staffing structures and materials. Step 3 tested the changes with small pilot groups and used feedback to improve the programme

before wider roll-out and refinement. Step 4 focused on maintaining and reporting the adapted programme.

This work offers a transferable approach for spreading evidenced health innovations, providing an example of local needs driving relevant change, and demonstrating how tools and teamwork can support the adaptation process of digital health programmes. This example has potential wider use for researchers and clinical staff tasked with delivering change, though highlights the effort and resource needed.

INTRODUCTION

Delivering recommended intensity of neurorehabilitation remains a persistent global challenge,¹⁻³ with workforce shortages, geographic disparities, and fragmented care pathways. Telerehabilitation may help address these gaps, offering comparable outcomes to face-to-face therapy and can increase access to specialist rehabilitation through flexible, remote delivery.^{4, 5}

NeuroRehabilitation OnLine (NROL) provides real-time, multidisciplinary, group-based, telerehabilitation with dedicated technology assistance.⁶ It combines targeted therapy with peer-support aiming to enhance access and opportunity for neurorehabilitation while making efficient use of the workforce. Recent publications provide a comprehensive description of NROL's components,⁶ and successful integration within the National Health Service (NHS) stroke and neurorehabilitation services in one region of England (Lancashire and South Cumbria).^{7, 8} These highlight NROL's alignment with national guidelines,^{9, 10} healthcare strategic priorities,¹¹⁻¹³ and its adaptability to local contexts.

Scaling evidence-informed practices, like NROL, is increasingly recognised as a strategic objective for health systems. The World Health Organization reports scale-up as “the deliberate

effort to increase the impact of successfully tested health interventions so as to benefit more people and to foster policy and program development on a lasting basis".¹⁴ Adaptation is a key part of successful scale-up, with careful attention required to how well an intervention will fit and function in the new context, including considering infrastructure, workforce, readiness, patient needs and sustainment. Despite the importance of reporting intervention adaptations, a recent review found many studies lack description in full.¹⁵ The ADAPT guidance was developed to provide a systematic, stepwise approach to support structured and transparent adaptation.¹⁶ Alongside ADAPT, TIDieR checklists provide structured tools for describing interventions in sufficient detail to support replication and fidelity.¹⁷⁻¹⁹ Despite their availability, to the authors knowledge no studies have formally applied both ADAPT and TIDieR comprehensively to describe innovation adaptation in the context of telehealth.

Combining complementary implementation science knowledge with the ADAPT guidance can help navigate the complexities of transferring interventions across diverse health systems.^{16, 20} The value of concurrent use of implementation science knowledge was also highlighted by Connell et al. (2025), using NROL as an example.²¹ They used the ADAPT guidance and the Consolidated Framework for Implementation Research (CFIR),²² in conjunction with the updated Medical Research Council framework for the development and evaluation of complex interventions²³ to develop, adapt, implement and evaluate NROL as a scalable regional innovation. Of note, incorporation of the CFIR enabled identification of Expert Recommendations for Implementing Change (ERIC) implementation strategies (through the CFIR-ERIC matching tool) to support implementation efforts, including for the adaptation phase.

Building on prior work, this paper focuses on adapting NROL for delivery in a new context, a second NHS region within England (Cheshire and Merseyside). Using the ADAPT guidance and TIDieR-Rehab checklist, the adaptation process is documented along with contextual considerations and applied implementation strategies. This publication aims to offer considerations for therapy staff, service leads, and digital health implementers seeking to adapt or scale other telehealth models.

METHODS

The process was iterative, and grounded in co-production principles with the adaptation of NROL applying complementary implementation science knowledge. Ethical approval was not required for this descriptive study.

Stakeholder co-production

A key feature of NROL's development, implementation and adaptation has been co-production, with key stakeholders (including therapy staff, service leads, patients, clinical-academics, and members of the stroke and neurorehabilitation community) actively shaping the innovation. This collaborative model supports contextual relevance, clinician buy-in, and patient engagement; factors known to influence implementation success and sustainability.²⁴

A coalition was built between Region 2 (Cheshire and Merseyside) and Region 1 (Lancashire and South Cumbria), facilitated by established connectivity between their regional stroke networks and a shared purpose to improve neurorehabilitation provision, with NROL identified as one possible solution. The adaptation of NROL for Region 2 was shaped by co-production principles emphasising shared power and mutual respect.^{25, 26} Individuals contributed their perspectives and skills with all forms of knowledge valued equally. Fostering reciprocal relationships, prioritising relationship-building and maintaining open communication, ensured the project met the needs of all stakeholders.

Positionality statement

The author team comprises clinical-academic staff, and operational, service and regional leads, embedded within the stroke and neurorehabilitation services across both regions involved in this study. Our direct involvement in the development, delivery, and adaptation of NROL provided deep

contextual insight and facilitated co-production. We acknowledge that our dual roles, as implementers and evaluators, may have influenced interpretation. To mitigate bias, diverse stakeholders were engaged throughout and structured frameworks used to guide and document the process.

Process for adapting NROL

Adaptation of NROL in Region 2 used a multi-tool approach, with selection of tools informed by complementary strengths in structuring adaptation processes; capturing contextual influences, ensuring transparent reporting, and fit within the larger programme of work previously described.²¹

The ADAPT guidance was the overarching tool.¹⁶ NROL was adapted to new contexts informed by four key steps, as outlined in Figure 1. This guidance was particularly suited to the current project, which aimed to scale-up an existing innovation to a new region while maintaining fidelity to its core components. Adaptation was supported using previously identified ERIC implementation strategies.²¹ ERIC strategies help inform actions to support effective implementation.²⁷ Strategies focused on stakeholder interrelationships, training and education, and evaluation and iteration.²⁸

In Step 1, the CFIR and ISAT supported contextual analysis. CFIR offered a comprehensive lens to systematically detail and compare contextual factors (innovation characteristics, outer setting, inner setting, characteristics of individuals) across regions.²² The ISAT provided a structured assessment of context-specific factors influencing readiness for scale-up, covering 2 parts: A- Background contextual information and B-Implementation and sustainability considerations (see Figure 2 for Domain headings).²⁹ Domains were scored between 0 (not at all) and 3 (to a large extent) by consensus and summarised via radar plot.

In Step 4, the TIDieR-Rehab checklist,¹⁸ with the Telehealth extension,¹⁹ was used to report the adapted innovation. The TIDieR-Rehab extends the original TIDieR checklist¹⁷ to better capture the complexity of rehabilitation interventions. Content for the TIDieR-Rehab checklist was systematically updated from Region 1's TIDieR checklist,⁶ with region specific content (new/adapted/removed) clearly marked.

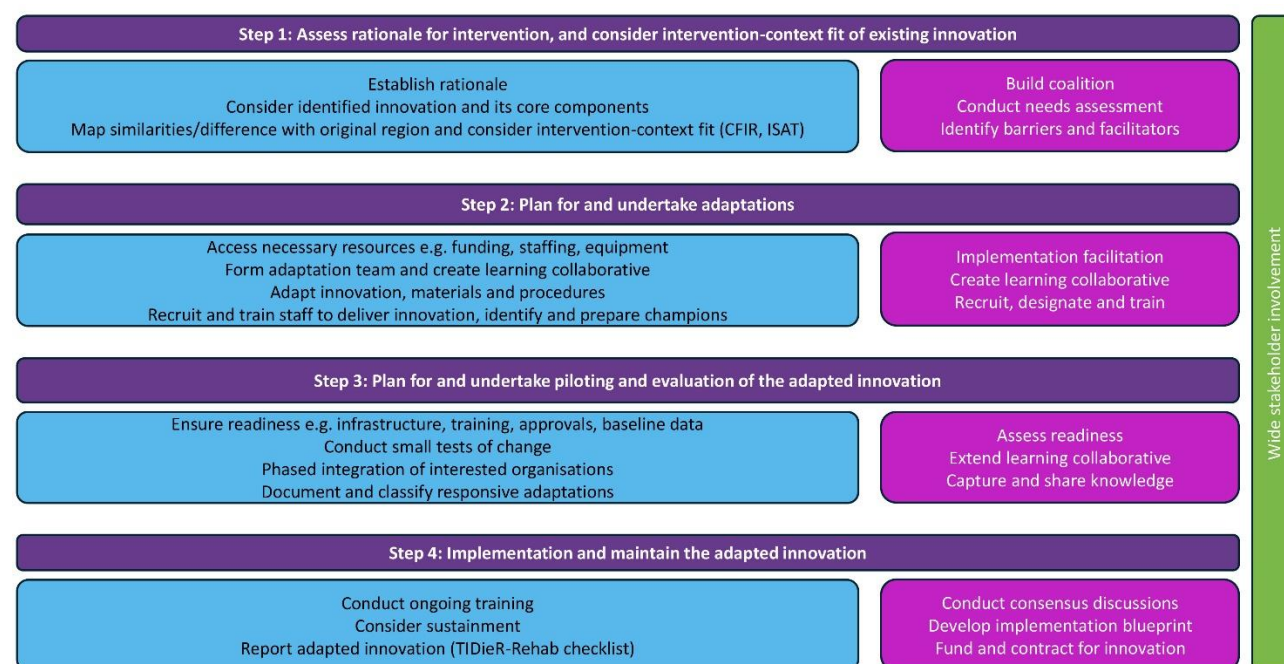


Figure 1. Process for adapting NeuroRehabilitation OnLine (NROL) to new contexts, informed by the ADAPT guidance,¹⁶ Consolidated Framework for Implementation research (CFIR),²² Intervention Scalability Assessment Tool (ISAT),²⁹ and reported with the TIDieR-Rehab checklist.¹⁸ Purple boxes = Steps of the ADAPT guidance. Blue boxes = Expected outcomes from each step. Pink boxes = ERIC implementation strategies applied.²¹

RESULTS

Step 1: Assess rationale for intervention, and consider intervention-context fit of existing innovation

Establish rationale, and consider identified innovation and its core components

Region 2 faced persistent challenges in delivering the recommended levels of stroke rehabilitation, compounded by workforce shortages and fragmented pathways, and anticipated increased

prevalence.³⁰ Regional Stroke Rehab Leads from the region's stroke delivery network identified NROL as a promising solution, informed by exposure at meetings, conferences and literature.

Map similarities/difference with original region and consider intervention-context fit.

Table 1 shows the comparison of the similarities and differences between Region 1 (original) and Region 2 (new) and identifies the barriers and facilitators to NROL implementation. This work was led by coalition members: two designated Regional Stroke Rehab Leads (RW,LJ) from Region 2, and the NROL Operational Lead (AP) and Clinical-Academic staff (SA,LC) from Region 1.

Key differences included that Region 2 was larger (population and number of organisations) and had a stroke-specific focus, with future ambition to extend to other neurological conditions. While most eligible organisations (10/14) showed interest in NROL, four opted not to participate due to competing priorities, or hesitancy around new initiatives and technology. Another difference was the absence of an established clinical-academic partnership for the project, contrasting Region 1 where such a partnership was central. Region 2, however, felt they benefitted from Regional Stroke Rehab Lead initiation and leadership, as they had existing knowledge of the 'people and processes' covering all organisations and recent technology project engagement, which could help expedite upfront implementation efforts (e.g. stakeholder engagement, governance approvals).

Key similarities included recognition that NROL had strong strategic alignment,^{11, 12} a significant facilitator. Both regions identified lack of workforce and resource, and varied service- and infra- structure across organisations as barriers for implementation. There was a preference to maintain dedicated NROL operational roles, however funding was needed to recruit staff. Two Technology Support roles were prioritised due to existing availability of therapy assistance within the workforce and the size of the region. Region 2 recognised NROL's potential to optimise workforce use and drew on Region 1's solutions to service challenges.

Table 1: Comparison of contextual factors between original and new regions, including barriers and facilitators to NROL implementation

	Region 1 (Original region)	Region 2 (New region)
<i>Innovation</i>	- NROL at Lancashire and South Cumbria	- NROL at Cheshire and Merseyside
<i>Outer setting (External influences)</i>	Aligns with healthcare system strategic priorities ^{11, 12} Ambition to increase therapy provision toward National Clinical Guideline targets ^{9, 10}	
<i>Inner setting (Regional setting)</i>	- 1.8 million people - Urban, rural and coastal areas - Areas of low deprivation and neighbourhoods with lower than national average healthy life expectancy	- 2.7 million people - Urban, rural and coastal areas - Areas of low deprivation and neighbourhoods with lower than national average healthy life expectancy
<i>Inner setting (Healthcare setting)</i>	- 4 organisations, 7 community stroke and/or neurorehabilitation teams involved - Not achieving guideline recommended amounts of therapy, ambition for equitable access to more rehabilitation - Initiated within an established clinical-academic partnership (ELHT/LU) - NROL champions identified over time - Leadership commitment - Dedicated NROL roles - Limited workforce and resource - Varied service- and infra- structure across organisations, and constantly changing - Fixed-term funding	- 10 organisations, 18 community and/or early-supported discharge stroke teams interested in involvement - Not achieving guideline recommended amounts of therapy, ambition for equitable access to more rehabilitation - Initiated by Regional Stroke Rehab Leads - Aware upfront effort required for implementation - Recent regional technology project, with members identified as potential champions for NROL - Leadership commitment - Strong clinician interest from prior NROL dissemination - Need for dedicated NROL roles - Limited workforce and resource - Varied service- and infra- structure across organisations, and constantly changing - Need for funding
<i>Individuals (roles)</i>	- Patients: Active service-users (≥18 years) with stroke or other neurological condition - Staff: NROL operational team (Lead, Technology Support, Assistant, Administrator), existing NHS therapy workforce across integrated organisations - Clinical-academic (ELHT/LU) and charity (SameYou) partners - Members of the stroke and neurorehabilitation community (Ex-NROL volunteer, Stroke Association Support Coordinators & stroke survivors) and student involvement	- Patients: Active service-users (≥18 years) with stroke - Staff : Need for NROL operational team (Lead, Technology Support (x2), Administrator), existing NHS therapy workforce across integrated organisations - No clinical-academic partnership - Potential for members of the stroke community (Stroke Association Support Coordinators) and student involvement

Bold, difference between regions. Green = Facilitator, Red = Barrier, Orange = Both facilitator and barrier. NROL = NeuroRehabilitation OnLine, ELHT = East Lancashire Hospitals NHS Trust, LU = Lancaster University, NHS = National Health Service.

Figure 2 depicts the factors influencing Region 2's context-specific readiness for NROL implementation. ISAT scoring showed NROL was seen as a valuable innovation, though not a panacea (A2). Funding needs (A5), infrastructure gaps (B4) and long-term sustainability were identified as areas for response, notably highlighting need for dedicated NROL operational staff.

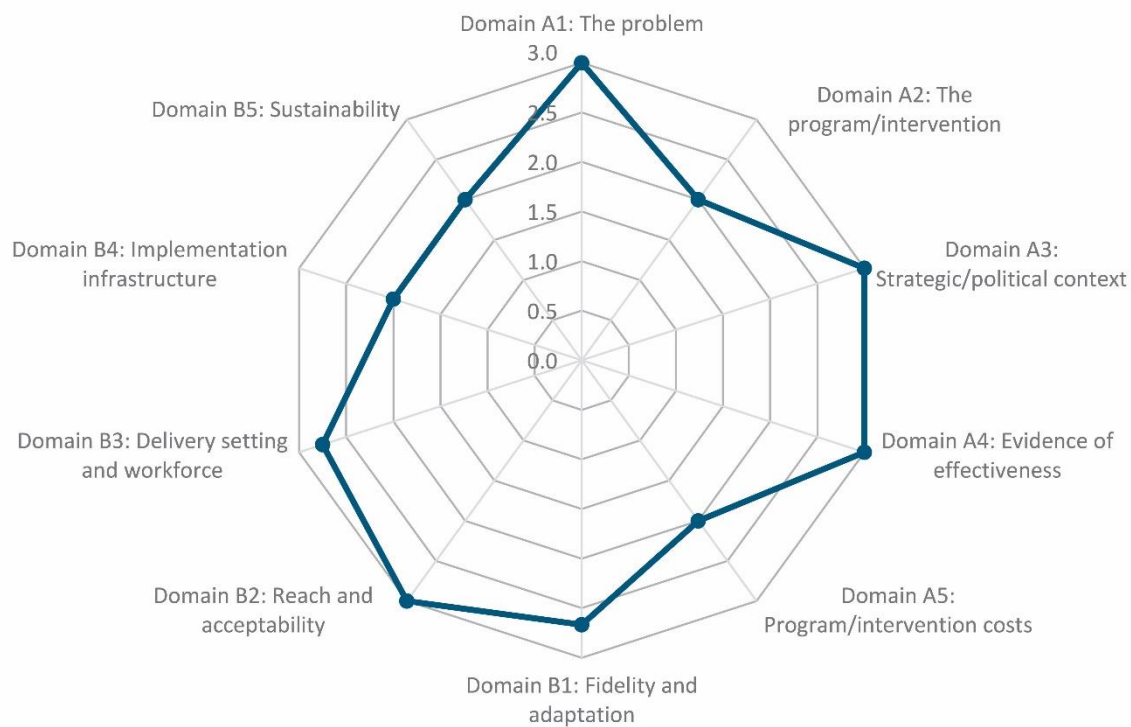


Figure 2. Intervention Scalability Assessment Tool (ISAT) radar plot depicting factors influencing Region 2's readiness for NROL implementation. Domains A1-5 focus on background contextual information and B1-5 on implementation and sustainability. Each domain is scored for readiness between 0 (not at all) to 3 (to a large extent), therefore facilitators are depicted nearer the outside of the circle and barriers more centrally.

Step 2: Plan for and undertake adaptations

Accessing necessary resource

In response to the identified barriers, seed funding was secured through a national health funding body enabling recruitment of the dedicated NROL operational team (including Lead, AB) and a modest budget for equipment and materials.

Form adaptation team and create learning collaborative

An adaptation team was formed comprising Regional Stroke Rehab Leads (n = 2, Region 2), NROL Operational teams (n = 8, both regions), and Clinical-Academic staff (n = 2, Region 1). The adaptation team met regularly to iteratively adapt NROL for Region 2. Adaptations were informed by Step 1, ongoing regional, organisational and service needs, and stakeholder feedback. The new region viewed the involvement of the original region positively.

A regional NROL learning collaborative was established, and was iterated over time, to support shared decision-making and co-production. This included existing workforce (regional technology project members, therapy staff, local administrators and decision-makers), patients, and members of the stroke community (Stroke Association Support Coordinators) from Region 2, alongside the adaptation team and Region 1's Stroke and Neurorehabilitation Service Manager (HV).

Adapt innovation, materials and procedures

Adaptations were planned and undertaken to achieve the best fit of the NROL core and peripheral components within Region 2, and key components are summarised in Figure 3. The remaining peripheral components were all maintained and are described in the TiDieR-Rehab checklist (Supplementary file). Responsive adaptations are detailed in Step 3.

All NROL core components were retained. The description of one core component was modified to clarify the model was intended for use in 'neurorehabilitation' rather than specifying stroke and neuro-rehabilitation.

Key NROL peripheral components were aligned with the relevant TiDieR-Rehab section headings, and categorised as either 'maintained' or 'adaptations'. The basic structure of NROL was maintained (i.e. How/How much). Planned adaptations were made to the 'Who' NROL was intended for and 'Who provided', and included offering NROL only to patients receiving stroke rehabilitation, and adjustment to operational team and leadership role configuration. Planned adaptations were co-

produced to 'What' materials with the learning collaborative, including updating key documents (shared by Region 1), gaining relevant governance approvals, and expanding NROL visibility with additional branding materials.

Recruit staff to deliver innovation, identify and prepare champions

Region 2 NROL leaders in collaboration with the learning collaborative, recruited NROL champions and group facilitators from high-readiness organisations. Innovation champions were key in supporting governance, advocacy, and troubleshooting. Facilitators received targeted training, including technology and procedural sessions, and Region 1 observations. Meetings were held for delivery staff, champions, and leaders, with updates shared to wider teams.

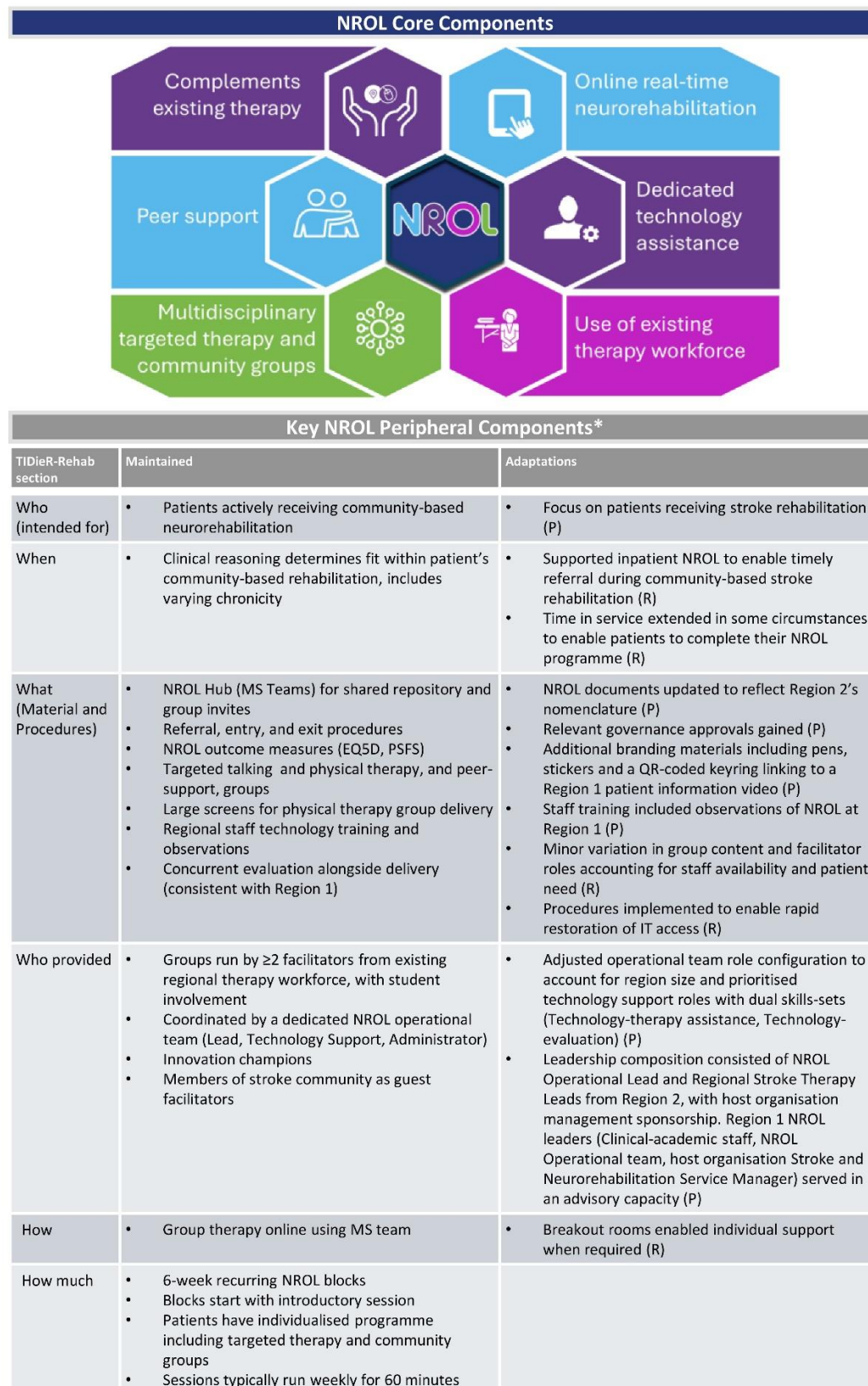


Figure 3: Core and key peripheral components for NROL adapted for Region 2. Key peripheral components are detailed under TIDieR Rehab sections. Planned adaptations (P) determined during ADAPT step 2 and responsive adaptations (R) during ADAPT step 3. *Remaining peripheral components were maintained and are detailed in the TIDieR-Rehab checklist (supplementary file).

Step 3: Plan for and undertake piloting and evaluation of the adapted innovation

Ensure readiness

Innovation readiness was confirmed by the Region 2 NROL operational team and champions once the infrastructure, training, equipment, regional approvals and staffing were in place. Organisational readiness required local approvals, staff training and baseline service data to provide a reference point for evaluation.

Conduct small tests of change

Pilot testing was initially conducted at group-level through two pilot groups: a fatigue management group and a speech and language therapy group. These allowed assessment of acceptability and practicality. Staff and patient feedback informed iterative refinements to processes, logistics and group content.

Phased integration of interested organisations

Following successful group-level piloting, block-level piloting began. This involved phased integration of organisations with high-readiness into 6-week NROL blocks running seven groups (Cognitive education, Emotional adjustment, Dysarthria, Aphasia, Balance and Mobility, Upper limb, Community peer-support).

All interested organisations were integrated. Seven organisations (8 teams) adopted the programme initially, one further organisation (3 teams) was added in the second block and two more (2 teams) in the third. Five teams remained pending. The learning collaborative expanded to ensure regional representation.

Evaluation ran alongside implementation and centred on reviewing key peripheral components, using routinely collected clinical and service-delivery metrics and stakeholder feedback

and was consistent with Region 1 evaluation. Region 2 NROL leaders co-produced summaries for stakeholders, including Region 1.

Document and classify responsive adaptations

Regular review meetings allowed iterative tailoring. Responsive adaptations are summarised in Figure 3 and included in the TIDieR-Rehab checklist (Supplementary file). Key responsive adaptations included tailoring to fit within the pathway such as supported inpatient participation and extended time in the community-based service when appropriate. Existing workforce influenced group content and facilitator roles (e.g. Allied health staff trained to lead well-being group). IT access issues prompted new resolution procedures, and breakout rooms (new functionality) were introduced, with procedures shared with Region 1.

Step 4: Implement and maintain the adapted innovation

Conduct ongoing training

Findings from pilot testing and evaluation informed ongoing training. Staff were encouraged to observe live NROL sessions, in both regions, to support referral decisions and experiential learning. Cross-region observation fostered shared learning and networking. New staff were introduced to NROL during orientation. New group facilitators received targeted training in both technology and procedures. General information about NROL was regularly disseminated by local and regional NROL staff and champions.

Consider sustainment

Sustainment was considered from the out-set and involved continued dialogue with wide stakeholders, including decision-makers. Presentations were made to organisation transformation and improvement leaders. Advantages of the programme were identified and included staffing efficiencies, increased therapy contact, and savings in travel time, cost, and carbon emissions.

A co-produced blueprint outlined full implementation and evaluation plans. Further fixed-term funding was secured, providing time to develop a business case for long-term regional investment. NROL delivery is ongoing.

Report adapted innovation described using TIDieR-Rehab checklist

The adapted NROL model for Region 2 was documented using the TIDieR-Rehab checklist, updated from Region 1's version⁶ to reflect adaptations (see supplementary file). This co-production process involved the Region 2 learning collaborative to ensure accuracy and resonance.

DISCUSSION

This study illustrates how the NROL telerehabilitation model was adapted for a new region using a structured, co-produced process. Core components were retained, while adaptations tailored role configuration, materials and fit within service pathways. The ADAPT guidance alongside implementation science knowledge provided a systematic approach to planning, piloting, implementing, and reporting the adapted model.

The adaptation process was initiated and led by Region 2 Stroke Rehab leaders who had relationships with local organisations and deep community knowledge facilitating implementation efforts. Involving the original region (Region 1) accelerated implementation by transferring tacit knowledge, tested materials, and credibility. While the ADAPT guidance warns working with innovation developers could risk fixed views or power imbalances,¹⁶ this did not materialise. The new region viewed the involvement positively, likely due to co-production principles, open dialogue, and mutual recognition. This approach provided a trusted environment to explore viable adaptations to meet local needs.

Creative solutions were fostered. Adjustments to role configurations and recruitment reflected the wider workforce landscape and leveraged diverse skill-sets. For example, Region 2

prioritised recruitment for two NROL technology support roles. The opportunity was harnessed to establish a patient-facing technology job creation, and capitalised on dual skill-sets (e.g. assistant workforce), that could help sustain digital practice. Another example, in response to a system-wide lack of psychology staff, involved allied health staff being trained to deliver a well-being group with oversight from a clinical psychologist. This role agility aligns with the recent UK stroke guideline emphasis on what needs to be done rather than who does it.⁹ Creative solutions were also found for promoting NROL access, such as optimising fit within the service pathways (e.g. early exposure through inpatient participation) and introducing new materials (e.g. QR-coded keyring to share a patient information video).³¹ It may be that these adaptations actively enhanced joint decision-making between therapist and patient about service delivery preferences.³²

Frameworks were applied selectively to help navigate the complexities of transferring across regions. The ADAPT guidance structured the adaptation process; CFIR and ISAT supported contextual analysis; and TIDieR-Rehab enabled transparent reporting. The process was non-linear, with evolving priorities. While these tools added rigour, they also introduced complexity. Overlapping constructs and terminology created challenges, requiring interpretive effort.^{23, 33} Co-production, including clinical-academic involvement, helped translate conceptual guidance into practice-relevant actions.^{24, 34, 35} Insights are summarised in the “Key Considerations for Adaptation” box, which may be helpful for researchers and implementers seeking to scale telehealth models.

Key Considerations for Adaptation

- Embed co-production and shared learning: Engage stakeholders throughout.
- Retain core functions, use creative solutions to meet needs: Tailor staffing models, materials and fit within pathway.
- Use structured guidance flexibly: Apply frameworks to support planning and contextual fit.
- Anticipate complexity: Expect evolving roles and shifting priorities.
- Plan for sustainment early: Co-produce a blueprint and highlight efficiencies.

A limitation was that the project focused on a single adaptation case within well-connected national health system regions. Findings may not generalise to less resourced or less connected contexts. The use of embedded teams and qualitative feedback limits external validation but offers rich, practice-based insights. Further evaluation is needed to assess sustainability, cost-effectiveness, and equity.

This paper highlights the complexity and effort required to adapt and sustainably scale interventions, a challenge often under-recognised in healthcare and funding agendas. It showed the value of working across silos and with the original region to share information, evaluation and know-how, including with decision-makers. Working as a cross-regional learning health system provided a means to accelerate the integration of NROL in the new context.³⁶ The resource demands of thorough adaptation underscore the need for sustainable, bottom-up funding models. The results affirm that strategic adaptation must address clinician, patient, service, and system-level factors, with clinical-academic partnerships a potential mechanism for translating frameworks into scalable, context-sensitive tools.³⁷

Conclusion

This study offers a transferable approach for scale-up, providing a real-world example of adapting a complex telerehabilitation model using structured implementation science knowledge. It offers practical insights into how core components can be maintained while adapting elements to new contexts. As digital models expand, structured and context-sensitive adaptation grounded in co-production and implementation science approaches, will be essential for sustainable scale-up across diverse health systems. These findings may inform broader efforts in digital transformation, workforce redesign, and service innovation beyond telerehabilitation.

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Declaration of Conflicting Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical considerations

Not applicable.

Consent to participate

Not applicable.

Data availability

Not applicable.

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Supplementary file 1: TIDieR-Rehab Checklist for NeuroRehabilitation OnLine (NROL) at Cheshire and Merseyside

The TIDieR-Rehab checklist¹ was used, informed by the Telehealth extension², to report the adapted NROL innovation at Cheshire and Merseyside (new region, Region 2).

Content was systematically updated from the TIDieR checklist described for Lancashire and South Cumbria (original region, Region 1)³:

- 1) The TIDieR checklist content for NROL at Lancashire and South Cumbria was reallocated into the sections of the TIDieR-Rehab checklist.
- 2) Each TIDieR-Rehab checklist section was updated to reflect components maintained and adapted with edits clearly marked to enable comparison:
 - **Bold font** for new/adapted content for NROL at Cheshire and Merseyside
 - ~~Strikethrough~~ for removed content
 - *Italics for additions/amendments* relevant to both regions

Supplementary Table 1 : TIDieR-Rehab Checklist for NeuroRehabilitation OnLine (NROL) at Cheshire and Merseyside

Item	Section	Explanation	Description
1	Brief name	Provide the name or a phrase that describes the intervention.	NeuroRehabilitation OnLine (NROL) at Cheshire and Merseyside
2	Why	Describe any rationale, theory or goal of the elements essential to the intervention.	NROL aims to enhance the rehabilitation offered for adult patients actively <i>receiving neurorehabilitation</i> . As part of a hybrid model of care, it utilises an online platform offering advantages to save time, energy and travel, enabling more therapy to be delivered using existing workforce. ⁴ Group therapy has favourable evidence, ⁵ leveraging the benefits of peer support. ⁶ By embedding NROL within the existing National Health Service (NHS) system, it supports sustainable service delivery. NROL aligns with strategic priorities, such as the use of data and digital technologies in healthcare. ^{7, 8} Collective use of the workforce, as a provider collaborative, fosters a community of practice and shared learning ⁹ <i>and helps support workforce capacity fluctuations</i> . NROL also allows for a critical mass of patients to receive group therapy where impairment incidence is low.
3	Who	Describe who the intervention is intended for.	Active community-based patients within stroke and neurorehabilitation services. This means patients are under an active episode of care at their local organisation and are part of a local treating therapist's caseload who is ultimately responsible for their overall rehabilitation and a key point of contact.
4	When	Describe when the intervention commenced in relation to the onset or stage of the condition and/or other relevant events.	Clinical reasoning should determine when NROL fits with a patient's overall rehabilitation. Patients are at varying chronicity.

5A and B	What	<i>Materials:</i> Describe any physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or in training of intervention providers. Provide information on where the materials can be accessed. <i>AND</i> <i>Procedures:</i> Describe each of the procedures, activities and/or processes used in the intervention, including any enabling or support activities	A secure ‘NROL hub’ collaboration platform (in Microsoft (MS) Teams) was created as a repository for shared resources <i>and group invites</i>. Key documents include an ‘NROL standard operating procedure’ and relevant approvals (e.g., Data Protection Impact Assessment). NROL branding (i.e., logo) increases visibility and facilitates team cohesion. The materials and procedures for NROL referral, entry, delivery and exit phases are detailed below: NROL referral materials and procedures: Therapy team members identify, consent and refer suitable patients to appropriate NROL groups. They submit an ‘NROL referral form’ via the NROL hub, guided by an ‘NROL staff manual’ (<i>available on request</i>). An ‘NROL patient information leaflet’ is provided to patients. NROL entry materials and procedures: NROL team support staff process referrals and coordinate timetabling using an NROL database (MS Excel). Prior to programme start, an NROL staff member contacts new patients to complete ‘NROL outcome measures’. Measures include the EQ-5D-5L for measuring health-related quality of life¹⁰ and the patient-specific functional scale (PSFS)¹¹ for measuring activity performance <i>with modified wording for use in a neurological population</i>, and are administered through the patients’ choice of either telephone or online questioning. Measures were chosen as they were consistent with existing data collection (e.g. NROL data collection at the original region, part of Stroke Sentinel National Audit Programme, UK), and had acceptable clinical utility according to the Tyson and Connell scale,¹² and measured domains identified within a NROL logic model as those the programme was aiming to influence. However, it is acknowledged that the measurement properties of these measures when obtained through telephone or online questioning is unknown, and the lack of outcome measures that have been tested psychometrically for remote delivery across neurological conditions is a challenge.¹³ Additionally, NROL technology support staff members ensure that each patient has the necessary technology capability and equipment (hardware, software (MS Teams and email) and connectivity) to access NROL. An ‘NROL technology support guide’ is provided, <i>as necessary</i>. Patients participating in physical groups receive an ‘NROL physical group guide’ providing instructions on how to set up a safe exercise environment. Patients (and referrer) receive a personalised ‘NROL entry email’ that outlines their 6-week programme, and group invites. NROL delivery materials and procedures: Patients join NROL groups according to their personalised programme. These include targeted talking (e.g., cognition, communication, fatigue, well-being) and physical (e.g., balance/mobility and upper limb) therapy groups incorporating interactive, educational and practical elements. These groups are staffed by at least two group facilitators, often jointly by more than one discipline. Community groups are offered to all patients and include an NROL introduction session and an optional weekly peer support group.
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			Throughout the programme and during each NROL session, technology assistance is available to both patients and staff. If a patient is expected to join a group but does not attend, the NROL technology support staff member makes contact to offer assistance. The maximum number of patients within a group is determined by the group facilitators to ensure the best experience for patients and staff. NROL sessions are delivered by staff online (MS Teams) using existing devices equipped with webcams and microphones. For physical groups, a large-screen television is used for monitoring patients during exercise. The session content is developed by group facilitators based on evidence-based practice and may include discussions, demonstrations and presentations. The NROL database is used during sessions to access and record patient information, such as attendance. A telephone is required in case of adverse events. Group facilitators ensure that clinical notes are entered for all patients. Regular NROL staff meetings and group-specific meetings are held to discuss NROL delivery. Patients participate in NROL using their agreed device. For patients in physical groups, a large screen device is necessary. Specific equipment, such as a frame or table, may be required to ensure stability. Patients are advised to wear comfortable footwear and clothing and have access to a suitable drink. Functional task practice may necessitate additional equipment, for example, pen and paper, kitchen items. Patients should have a telephone available in case of technology issues or adverse events. If patients have pendant alarms, they are encouraged to wear them. NROL exit materials and procedures: Patients (and referrer) receive an 'NROL exit email' that provides summary information. Outcome measures are repeated, and patients are asked to complete a satisfaction survey. Evaluation: Evaluation occurs concurrently with NROL delivery, and consistent with NROL Lancashire and South Cumbria.^{4, 14} Service and patient-level data are sourced from the NROL database. The NROL leads undertake regular relevant analysis and summarise the data for feedback for multiple clinical and wider audiences. Staff training: NROL evaluation findings are discussed in NROL meetings as a basis for training. General NROL information is disseminated to staff across the participating trusts by NROL staff. Shared learning sessions, <i>including across regions</i>, are run to optimise knowledge translation. <i>Group facilitators receive one-on-one technology assistance</i>. New staff members are introduced to NROL during their orientation. Staff can observe NROL sessions for experiential learning.
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6	Who provided	For each category of intervention provider (for example, psychologist, nursing assistant), describe their expertise, background and any specific training given.	Existing workforce: NROL uses an existing NHS workforce alongside dedicated NROL roles for operations, administration and technology support. NROL therapy staff: Therapy staff (including nominated NROL champions and group facilitators) from stroke and neurorehabilitation services community and/or early supported discharge stroke teams (from integrated regional organisations) comprising Occupational therapists, Physiotherapists, Speech and Language therapists, Psychologists, <i>Dieticians</i>, Pharmacists, Therapy assistants and Allied health and psychology students. Ambition to include Pharmacists and Psychology students. NROL team support staff: Two dedicated NROL technology supports with dual skill-sets (Technology-therapy assistance, Technology-evaluation), NROL administrator, local organisation administrators. Patient and public involvement: Volunteers comprising ex-NROL patients and members of the stroke community as group facilitators (e.g. Stroke Association Support Coordinators for peer-support discussion group). Ambition for Ex-NROL patients to be group facilitators. To date, patients are part of the regional NROL learning collaborative supporting co-production activity (e.g. review of group resource information, feedback for group content). Leadership: Dedicated NROL operational lead and Regional Stroke Rehab leads, with host organisation management sponsorship. Original region NROL leaders (Clinical-academic staff, NROL operational lead, host organisation Stroke and NeuroRehabilitation Service Manager) served in an advisory capacity.
7	How	Describe the modes of delivery (such as face to face or by some other mechanism, such as internet or telephone of the intervention and whether it was provided individually or in a group.	Mode of delivery is online (MS Teams) and sessions are delivered <i>synchronously (i.e. in real-time)</i> by staff to groups of patients. This section overlaps with the ‘What (material and procedures)’, see Section 5.
8	Where	Describe the type(s) of environment(s) where the intervention occurred, including any necessary infrastructure or relevant features.	Group facilitators and the NROL technology support staff member/s attend from private, well-lit, and quiet workspaces at different geographical locations and organisations. Resourceful use of available workforce is encouraged, such as enabling staff to deliver NROL whilst working from home. A room with adequate space is required for demonstrating exercises for physical groups. Patients participate in NROL groups from their homes.

9	How much	Session duration: Specify the planned session(s) duration of the intervention	Patients join NROL groups according to their personalised programme, with most sessions scheduled for 60 minutes.
		Essential elements amount: Specify the planned session(s) duration and/or repetition of the essential elements of the intervention.	<i>Active participation is promoted for approximately 50 minutes of the session, with about 5 minutes at the start of the session allowing for patients to join and 5 minutes at the end allowing for general discussion. Time-on-task has not been recorded for this group therapy. Patient participation can be dependent on level of engagement.</i>
		Frequency: Specify the planned frequency of the intervention	An NROL introductory session runs at the start of each block. Most targeted therapy groups run weekly.
		Intervention length: Specify the planned overall length of the intervention	NROL delivery is structured into recurring 6-week 'NROL' blocks to facilitate patient flow.
10	How challenging	Describe the approach(es) used to set and monitor the intervention/task challenge level.	The needs of patients in groups will be nuanced over time requiring a responsive approach. <i>Patients are encouraged to work at their challenge point. Staff monitor as relevant i.e. Clinical observation, discussion, measures (e.g. 'rating of perceived exertion').</i>
11	Regression/ Progression	Describe the planned regression and/or progression of dosage parameter(s), including when and how.	Patients can attend more than one NROL block if clinically indicated, providing they remain under the active care of their stroke or neurorehabilitation team.
12	Personalisation	Needs: If supplementary strategies were planned to enable the delivery of the essential elements of the intervention in response to specific individual or group needs, then describe what, why, when and how. Preferences: if the intervention was planned to be adapted for personal preferences, then describe what, why, when and how.	<i>Individualised 1:1 technology assistance as required. Signposting to external agencies to support technology access.</i>
		Preferences: if the intervention was planned to be adapted for personal preferences, then describe what, why, when and how.	<i>Patients may join talking therapy or community groups with cameras off if discussed with NROL staff and considered appropriate, though this is discouraged. This does not apply to physical groups where camera use is mandatory.</i>
13	Protocol deviations	If there were deviations in the intervention protocol during the course of the study, describe the changes (what, why, when and how)	Changes were made to when NROL was commenced relative to stroke onset. Staff were encouraged to offer inpatients the opportunity to trial NROL sessions with therapy staff support, to facilitate timely NROL referral during community-based stroke rehabilitation. In some services, the length of time in the active care of the team was extended to enable patients to complete their NROL programme. <i>MS Team Breakout rooms were introduced to enable individual support if required (e.g. technology issues, management of adverse events).</i>

			Tailoring is required at patient, group and block levels. All referrals are screened by group facilitators to ensure session content is tailored. The structure of blocks, in terms of groups offered and frequency, actively considers patient need, workforce availability and capitalises on changing staff skill sets. Session content, shared by Lancashire and South Cumbria, was tailored overtime. Minor variations in facilitator roles (e.g. Allied health staff trained to lead well-being group). NROL materials are continually edited to reflect updates. Procedures implemented to enable rapid restoration of IT access.
14	How well	Plan: If intervention adherence or fidelity was assessed, describe how and by whom, and if any strategies were used to maintain fidelity or improve fidelity, describe them.	Communications, resources and technology assistance are provided to optimise NROL entry and participation (see Section 5). Service data are obtained and reviewed to monitor performance.
		Actual: If intervention adherence or fidelity was assessed. Describe the extent to which the intervention was delivered as planned.	Implementation and evaluation of NROL in Cheshire and Mersey is ongoing and will be reported separately.
15	Harms	Plan: Describe the monitoring of adverse consequences.	Adverse consequences are recorded.
		Actual: Describe any adverse consequences, including the number, seriousness and relatedness to the interventions	Implementation and evaluation of NROL in Cheshire and Mersey is ongoing and will be reported separately.

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