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Neuro-Rehabilitation OnLine (N-ROL): Description and evaluation of a group-based telerehabilitation programme for acquired brain injury

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Appendices 1

Intense rehabilitation after stroke and other forms of acquired brain injury (ABI) can lead to large clinical improvements[1-3]. The arrival of Covid-19 in early 2020 influenced stroke presentations[4], but reduced opportunities for rehabilitation[5]. The necessity to avoid face-to-face contact and to reach as many patients with as few staff as possible led to a three-way collaboration between UCL, UCLH and SameYou charity to set up a comprehensive, multi-disciplinary group-based neurorehabilitation on-line (N-ROL) programme. N-ROL involved physiotherapy, occupational therapy, speech and language therapy, neuropsychology and neurology. Here we describe N-ROL (TIDieR checklist, Table S1) and report our quantitative evaluation. N-ROL is registered with UCLH Quality and Service Department as a service evaluation (Reference Number 55-202021-SE).

Patients were referred by community or hospital-based rehabilitation teams and screened via telephone. Inclusion criteria: confirmed ABI; <6 months from hospital discharge; English speaking; willing to engage in online group-based sessions. Exclusion criteria: no access to computer hardware. Triage into specific groups was carried out in the same call if participants were suitable and refined in an initial 'meet the team' group session. There was no limit to the number or type of sessions individuals could take part in, although the number of participants per session was capped for some groups (Table S2).

Assessments were completed immediately before and after completion of N-ROL in a repeated-measures design. We expected that most patients would participate in a range of groups through which their knowledge and confidence to pursue recovery would be enhanced. Rather than use limited resources on domain specific outcome measures, we therefore wanted to test the efficacy of N-ROL as a whole. Our first outcome measure was the Stroke Self-Efficacy Questionnaire (SSEQ), a Likert scale (0-3) questionnaire with 13

questions with good criterion validity[6]. Our second outcome measure Neuro-Rehabilitation OnLine Outcome Measure (N-ROLOM), a novel Likert scale (1-5) questionnaire with seven questions for patients and two for carers/family (Appendix). The questions were constructed from themes derived from semi-structured interviews with five early participants and two carer's and so has good construct validity, reflecting the context (Covid-19 pandemic) in which the N-ROL programme was being delivered.

We tested the hypotheses that N-ROL would lead to an improvement in these outcome measures using paired t-tests. Statistical significance was set at p value < 0.05. We quantified change using a standardised (Cohen's *d* for repeated measures data) and unstandardised measure. The latter is a calculation of how much of the gap between the patients' baseline score and the highest possible score has been closed: the %maximum possible change. We performed post-hoc analyses (paired t-tests) to see which questions were driving any significant effects.

A total of 144 patients were referred over 15 weeks. Note, 58 referrals did not progress to N-ROL: 13 did not meet the inclusion criteria, 12 were opposed to group-based treatment, 13 were opposed to internet-based treatment, 11 felt they had recovered or were receiving enough treatment, and 3 were unwell or uncontactable. Six patients planned to start N-ROL, but never attended due to work/college commitments, internet difficulties, or opposition to groups. Of the remaining 86 patients, pre-/post- data were collected on at least one of the outcome measures for 74 patients (Figure S1). Summary demographic details of the 74 are as follows (median [IQR]): Age, (65 years [54-74]); days post-injury, (81 [34-174]); Gender, 50% female; cause of ABI, stroke 95% (infarct 60%, haemorrhage 35%), trauma/other 5%; for those with a stroke and an NIHSS admission score (n=36, 4 [2-9]); living alone, 15%. Only 22

participants had additional community rehabilitation during N-ROL, ranging from 45 minutes once a fortnight to 4x30 minute sessions a week, with a median 1.5 30-45 minute sessions a week.

Each patient attended on average 27.1 session, a mix of physical and talking therapies (Figure S2), with an average of 5.4 patients per group. Data for each type of group is shown in table S2. The structure of N-ROL interventions (numbers of sessions, participants per session) remained unchanged throughout the 15 weeks but the content of each group was iteratively adapted based on the needs and feedback of the participants.

Complete pre-/post- data were available for SSEQ and NROLOM for 67 and 68 patients respectively. Carer/family data (NROLOM) were available for just over half of participants (either no carer or unable to contact them).

There was a significant improvement on the SSEQ, $t(67)=2.28$, $p=0.026$, pre=25.9, post=27.8. The standardised effect size was small (Cohen's $d=0.28$) with a 14% average maximum possible change.

The post-hoc analyses revealed that this effect was driven by four questions: 1) Prepare a meal you would like for yourself ($p=0.022$); 2) Continue to do most of the things you liked to do before your stroke ($p=0.030$); 3) Walk safely outside on your own on any surface ($p=0.030$); 4) Walk a few steps on your own on any surface inside your house ($p=0.047$).

There was a significant improvement on the patient-based NROLOM questions, $t(68)=3.97$, $p<0.0005$, pre=23.8, post=26.0. The standardised effect size was medium (Cohen's $d=0.48$) with a 20% average maximum possible change (Figure 1).

The post-hoc analyses revealed that this effect was driven by three questions: 1) Other stroke/brain injury survivors have helped me understand my own stroke/brain injury (p<0.0005); 2) I understand why I suffered a stroke/brain injury (p=0.014); 3) My day has a clear structure to it (p=0.032).

There was no significant improvement on the carer-based NROLOM questions, $t(33)$=-0.90, p=0.374.

In summary, patients who took part in N-ROL significantly improved on the two planned quantitative outcome measures. The post-hoc -analyses suggest that participants gained the most from (i) psychoeducation around ABI, including hearing other people's stories, (ii) gaining advice on how to better structure their day and (iii) perceived improvements in their motor function (meal preparation, balance and walking).

N-ROL, like all therapist-delivered rehabilitation, is complex with many interacting components. Each group was delivered by highly skilled and specialist neuro-trained therapists. We speculate that key elements to its success are: (i) the multidisciplinary structure of the team; (ii) using groups, which allows participants to gain and identify with each other; (iii) the holistic and systemic nature of our therapeutic approach (treating patients in their own home and targeting their carers for specific interventions). Analysis of the qualitative data will shed further light, but it is important to acknowledge that this intervention is at an early stage of development.

The absence of a control group precludes attributing these gains to N-ROL. However, it must be remembered that the rationale for starting N-ROL was to offer treatment/support in their own homes for recently discharged ABI patients who would otherwise receive minimal or no treatment[5] (75% of our patients). Future direct comparison with a no-treatment control

group is unlikely to be feasible, but comparisons with existing community rehabilitation programmes, both in terms of clinical outcomes (general and domain specific) and cost-effectiveness would be of interest. We anticipate the emergence of hybrid online and face-to-face community treatment programmes in future, which may be tailored to local demographic and geographic needs.

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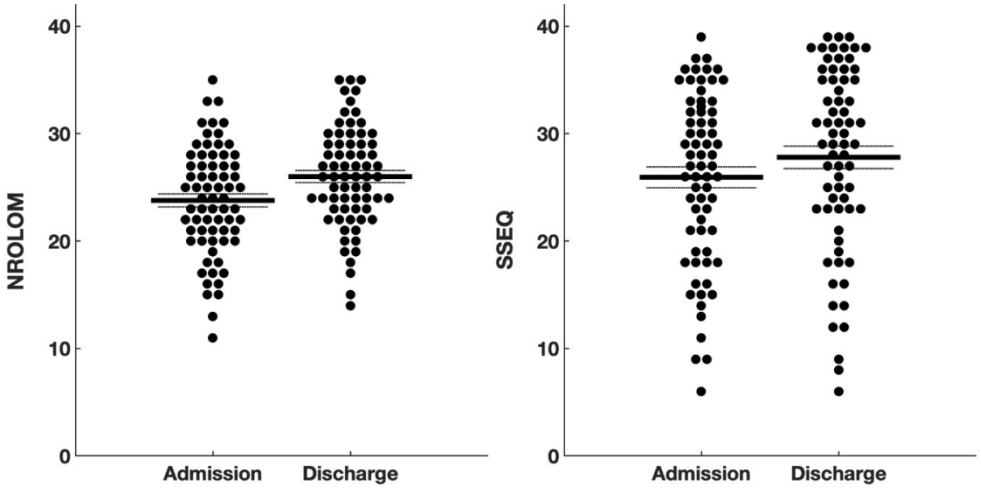
Figure Legends

Figure 1 Pre and Post mean scores (solid lines) with their associated standard error of the mean (dotted lines) for the two main outcomes: Neuro-Rehabilitation OnLine Outcome Measure (NROLOM, max score = 35) and Stroke Self-Efficacy Questionnaire (SSEQ, max score = 39).

Figure S1 CONSORT diagram

Figure S2 Number and type of sessions undertaken by the 74 patients with complete outcome data (x-axis). Patients are ranked from lowest to highest in terms of total number of sessions attended (y-axis). Talking sessions are in red and physical in blue.



Pre and Post mean scores (solid lines) with their associated standard error of the mean (dotted lines) for the two main outcomes: Neuro-Rehabilitation OnLine Outcome Measure (NROLOM, max score = 35) and Stroke Self-Efficacy Questionnaire (SSEQ, max score = 39).

29x14mm (1200 x 1200 DPI)

Table S1: TIDieR description of N-ROL@QueenSquare

1.	Brief name	Neuro-Rehabilitation OnLine (N-ROL) @Queen Square
2.	Why	<u>Overall programme</u> • N-ROL was conceived in response to the Covid-19 pandemic. Its purpose was to provide community-based neuro-rehabilitation for patients who were receiving less neurorehabilitation than usual, either because of (i) being discharged from hospital earlier than usual (to create clinical capacity for Covid-19 patients), and/or (ii) receiving less community-based therapy because of fewer home visits by community neurorehabilitation teams. • N-ROL attempted to cover as many clinical services that would be available from a multi-disciplinary neurorehabilitation team (see section 4). N-ROL was delivered entirely online because of early Covid-19 restrictions to delivering face to face treatment. • N-ROL sessions were run mainly by one or two therapists and attended by groups of patients. The group-based format was used primarily for pragmatic reasons (to increase the number of patients who could be supported), whilst acknowledging potential benefits (peer support, reduced isolation). Here we review the evidence supporting (1) group-based approaches, (2) Telerehabilitation (1) <u>Group-based rehabilitation</u> • N-ROL employed a group-based approach in order to treat as many people as possible, although there are some theoretical benefits, e.g. peer support. Peer support is seen by stroke survivors as valuable because it can facilitate the sharing of experiences, social comparison, vicarious learning, and increase motivation and feeling of helping others (Clark E et al. Disabil Rehabil. 2020 Feb;42(3):307-316; Sadler E et al. Health Soc Care Community. 2017;25(5):1590-1600). • Individual and group intervention formats have been directly compared in patients with acquired brain injury. The individual intervention led to performance gains in goal-specific areas, whilst gains in behavioural competency and psychological well-being were more likely to occur after the group interventions. (Ownsworth T, J Rehabil Med 2008; 40: 81–88). • Group-based rehabilitation programmes have been examined in all domains addressed by N-ROL. • <u>Physical – gait/balance:</u> Group-based interventions to promote fitness are well recognised e.g. circuit training (English C. J Rehabil Med. 2011 Jun;43(7):565-71). In general, people with stroke viewed training at higher intensities in a group-based

		programme as a facilitator, not a barrier, to engagement in exercise rehabilitation (Signal N et al. NeuroRehabilitation. 2016 Oct 14;39(4):507-517). • Physical – upper limb: Group-based constraint-induced movement therapy is feasible and effective (Galvão F et al. Medicine. 2021;100(8):e24864) but group-based upper limb interventions have not been widely investigated. • Aphasia: In aphasia, group treatment can lead to greater initiation of communication and social inclusion as therapy is delivered in a more normative social milieu (Fama ME. Top Stroke Rehabil. 2016 Aug; 23(4): 276–283.) • Cognitive: The efficacy of individual and group intervention formats has been demonstrated for improving a range of cognitive and behavioural impairments and psychosocial outcomes (Cicerone KD et al. Arch Phys Med Rehabil 2005; 86: 1681–1692). In the memory domain for example, there is evidence to support the efficacy of group-based treatment programmes (Miller L & Radford K, Neuropsychol Rehabil. 2014;24(5):721-37). Participants have previously reported finding groups supportive and non-judgemental where they could share their difficulties and exchange ideas. Participants also appreciated the opportunity for social interaction and felt valued as a group member (Chouliara N & Lincoln N, BMJ Open. 2016 Sep 19;6(9):e011225). • Emotional: Group psychotherapy offers a therapeutic venue where interpersonal learning can happen by sharing lived experiences of their brain injury (Klonoff, P., Applied Neuropsychology. 1997; 4(2), 107. • Caring Café: The role and ultimately the support of carers are well-known correlates of improved recovery for the brain injury patient. Group processes have been shown to increase emotional acceptance and valuing peer support (Williams, J., Social Care & disability. 2014 Feb.5:1. 29-40 • Considerations: Although widely considered acceptable, group-based interventions require careful consideration of dosing, fatigue and the interpersonal factors that facilitate appropriate level of delivery, the trainer to participant ratio. Also important are enhancing features that support continuation of activity postintervention (Norris M et al. BMJ Open. 2018;8(7):e022175) e.g. providing summaries of the talking therapy groups to aide memory and practice videos for continued physical rehabilitation. (2) Telerehabilitation • N-ROL employed a telerehabilitation approach out of necessity, due to dramatically reduced face to face contact during the Covid-19 pandemic. Telerehabilitation for stroke recovery has been used to address several domains (Tchero H et al. Med Internet Res. 2018 Oct 26;20(10):e10867). However, there are no examples of it being used in a group format, although this

		has been demonstrated in other long-term conditions, e.g. pulmonary rehabilitation (Cox N et al. BMC Pulm Med. 2018 May 15;18(1):71), falls prevention (Hawley-Hague Het al. JMIR Rehabil Assist Technol. 2021 Jan 12;8(1):e19690). • Telerehabilitation is generally considered feasible, although group based telerehabilitation in recently discharged geriatric patients has been more difficult , largely due to cognitive decline or inability to use/access a computer (Jørgensen B et al. Eur Geriatr Med. 2021 Feb 5;1-8).
3.	Physical and informational materials	<u>Frequently Asked Questions</u> • Patient information about N-ROL and answers to frequently asked questions were provided online (https://www.ucl.ac.uk/ion/sites/ion/files/n-rolqs_patient_information.pdf). <u>Screening Tool</u> • NROL screening was carried out using a screening questionnaire (https://www.ucl.ac.uk/ion/sites/ion/files/n-rolqs_screening_tool.pdf) by phone to orientate patients to the N-ROL programme and ensure they were able to access the online platform. The following information was collected and uploaded to the UCLH Trust electronic patient records (EPIC). o Emergency contact phone number o Use of pendant alarm o For those living alone we asked for details of home access in the case of falls o Participants were asked about factors that might limit physical exertion, e.g., joint problems/pain, heart conditions, recent surgery, any long term conditions o Current post stroke exercise understanding was assessed using 3 questions based on the Physical Activity Vital Sign (PAVS). This allowed the Physiotherapist to tailor education sessions and help stratify patients into appropriate groups. o Additional therapy input, so the NROL team could make contact with Community treating therapists when necessary and work on avoiding clashes with face-to-face sessions. <u>Outcome Measures</u> • Materials needed for collecting outcome measures: o Neuro-Rehabilitation OnLine Outcome Measure (NROLOM, see appendix). o Stroke Self-Efficacy Questionnaire (SSEQ), Riazi A. J Rehabil Med. 2014;46:406. <u>Hardware/Software</u> • Patients/carers use their own hardware and internet connection to access N-ROL. Information on how to do this was provided (https://www.ucl.ac.uk/ion/sites/ion/files/n-rolqs_zoom_setup_2.pdf) .

- Most groups were run by therapists/clinicians from computers with wired ethernet cables. A proportion of sessions were run by therapists from their own homes using wifi.
- We used Zoom to communicate with patients because of the ability to: host multiple callers, to enable the group facilitator to manage the intervention for people less familiar with this technology e.g. by using the mute button if some patients background noise was interfering with the session.

Preparing For Sessions

- For session preparedness, we gave participants guidance on how to setup the room (see below) and emailed details about what to expect during the session. To ensure accessibility the only equipment used (in physical fitness sessions) was a walking stick (or equivalent length stick), a chair and any mobility aids normally used by the participant, as required.
- Brief descriptions of each session were provided (as video or written) for referrers and potential participants to review online at https://www.ucl.ac.uk/ion/research/departments/clinical-and-movement-neurosciences/people/ward-lab/neurorehab-online-queen-1
- Prior to Physical Fitness sessions, participants were sent the following email: *Please ensure that you have a chair available ideally with rigid arm rests and a walking stick or light rigid pole (a broom handle is fine). Please set up the room so you have freedom to move in all directions as indicated by the white tape star in the image provided (see below). Please remove or ask your carer to remove any trip hazards (such as loose rugs) and if you wear a pendant alarm please wear it throughout the sessions. Ideally you will set the camera up high so I can see your whole body. However, it is most important that you can hear my instructions, so I can be flexible to whatever you are able to achieve.*

Similarly, for the Lying Pilates sessions participants were given instructions to position their device where they could

		comfortably view and hear the instructor whilst completing the exercises lying on the floor or a bed. Discharge Pack Materials • Once each participant had completed N-ROL they were provided with a discharge pack. *Upper Limb groups* • Attendees of the Upper Limb groups were given individual upper limb exercises and Activities of Daily Living (ADL) practice guides based on their goals and what they had covered in the groups. *Physical Fitness groups* • For attendees of the Physical groups: pre-recorded 30 min example videos were recorded for participants of each level (see links below). This gave participants reminders of key elements of sessions to help them self-management their ongoing strength and conditioning. Physical 1 example session: https://m.youtube.com/watch?v=gQ0yXvmi5nU&feature=youtu.be Physical 2 example session: https://m.youtube.com/watch?v=H5e29KU4w9U&feature=youtu.be Physical 3 example session: https://m.youtube.com/watch?v=fdb2eZ8l3zs&list=PL0ZsVFh-uVHfzf4Q8Gk17bUBjH7WUQopH&index=4&t=2093s • *Saebo UK* also produces a free 'Stroke Exercises for the Body' handout; a global post stroke exercise guide, that was provided for all participants. • Links were also provided to online resources or charities. The following links were provided GRASP manuals: https://neurorehab.med.ubc.ca/grasp/grasp-manuals-and-resources/ Reps App: For Apple smartphone/tablet: https://apps.apple.com/au/app/repsrecoveryexercises/id1453626110 For Android smartphone/tablet: https://play.google.com/store/apps/details?id=katescrivener.repsrecoveryexercises& Stroke Education Lectures: http://strokeed.com/about-workshops/free-lectures/ Different Strokes: Exercise and Support groups: https://differentstrokes.co.uk/what-we-do/find-a-support-group/ *Talking Therapy Groups* • For talking therapies, written strategies for improving and maintaining psychological well-being were provided. In addition, the following links were provided.

		• Stroke Association Complete Guide to Cognitive problems after stroke: https://www.stroke.org.uk/sites/default/files/complete_guide_to_cognitive_problems_after_stroke.pdf • For accessing local psychology services for mood: https://www.nhs.uk/service-search/find-a-psychological-therapies-service/ • For accessing cognitive assessment and cognitive rehabilitation: https://www.uclh.nhs.uk/OurServices/ServiceA-Z/Neuro/NPSY2/Pages/Home.aspx • For getting support going back to work: https://www.uclh.nhs.uk/OurServices/ServiceA-Z/Neuro/TS/Pages/VocationalRehabilitationService.aspx • We also provided people with a list of tertiary NHS services participants could access at The National Hospital for Neurology and Neurology and Neurosurgery which were not dependent on residential location: Vocational Rehabilitation, Upper Limb Service, Orthotics, Electrical Stimulation, Aphasia, Visual Impairments, Neglect management, Fatigue Management and Psychology, via a GP referral. Many participants had already been referred as part of their NROL discharge plans. • Information sheets also informed participants about third sector exercise charities such as: ○ Local Exercise Groups for Stroke 'LEGS', ○ Ability Bow, ○ Different Strokes, ○ Action for Rehabilitation from Neurological Injury (ARNI). • Many participants had expressed a desire to be referred into *LEGS* when NROL finished so they could continue their exercise progression, so several Physical participants were handed over this team on completion of the project. In addition, we informed participants of stroke and brain injury charities such as: ○ Same You, ○ The Stroke Association ○ For TBI participants Headway. • We also made participants aware of a telephone outreach service set up by The Stroke Association over the Covid 19 crisis called *Stroke Association Connect.* • For three participants with limited incomes successful applications were made to *The Lady Samaritans charity* to purchase personal Neuromuscular stimulation devices. This allowed participants to use these devices as adjuncts to their ongoing upper limb rehabilitation after the NROL project stopped.

4.	What (procedures)	Comprehensive interdisciplinary intervention tailored to participants' needs. Referral information was used to book patients into appropriate groups, but patients were able to self-refer to groups, if spaces were available. Groups were limited in the total number of participants at any one time (given in brackets for each group). Some groups allowed participants to join at any time, but others were 'closed' meaning that participants move as a cohort through a fixed number of sessions (indicated by *). **PHYSICAL THERAPY GROUPS** Physical groups were stratified according to ability. Sessions were generally 30 – 40 minutes in duration. The groups were designed to only require a chair, a stick and mobility aids as required in a small space. This meant living space or access to equipment were not factors in being able to participate in groups. A matrix approach was adopted under the guidance of Nikki Penny and Helen Weaver of *Neurofit* using protocols developed by Bob Wood of *Physical Solutions*. This involved breaking the sessions into six-minute blocks of Cardiovascular Exercise, Strengthening, Endurance and Balance. These were arranged so participants would get relative rest from one form of exercise while maintaining continuous effort throughout the session. Upper Limb groups were jointly delivered by Physiotherapists and Occupational Therapists from the Queen Square Upper Limb service. Weekly 30 sessions of Seated or Lying Pilates was provided for all participants by Kate Bull of *NeuroConnect*. N-ROL participants therefore received at least three physical sessions per week (including Pilates). Participants who attended weekly upper limb groups would therefore have four weekly physical sessions. Screening and liaising with medical teams was used to ensure participants were suitable for the cardiovascular components of the program. Cardiovascular exercise involved working participants sub-maximally as per the PROPEL: PRomoting Optimal Physical Exercise for Life, Toronto Rehabilitation Institute–UHN. Guidelines Version date: 20 Nov 2018. However, as Electrocardiogram (ECG) monitoring was not possible; the 'talk test' prompt based on moderate intensity perceived effort scales was used. This asks participants to exercise so they can 'talk but not sing' during the activity. Some Physical 3 groups were progressed to more vigorous activity using the prompt of being able to 'talk but only in short sentences'. This was after participants had become used to regular exercise. These prompts are based on the Centre for Disease Control and Prevention guidelines: https://www.cdc.gov/physicalactivity/basics/measuring/index.html.

		One to One sessions were provided to participants if factors such as shoulder pain or getting on and off the floor were potential barriers to participating in groups. In addition, this allowed therapists to give education, advise and treatments that related to specific individual goals. **<u>Physical 1 (8 pts/group)</u>** **Assistance with sit-to-stand and for those who can't walk 10m** • The focus of this group was improving confidence and independence with sit to stand and standing to sit. • Components of sit to stand were practiced in addition to lower and upper limb strengthening in postural positions that related to sit to stand. • Cardiovascular work involved seated boxing, seated marching and marching in supported standing **<u>Physical 2 (10 pts/group)</u>** **Using an aid to stand and can walk 10m** • The focus on this group was to work on independent standing and improving balance (including strengthening ankle strategy). • Squats and lunges were practiced in multiple anatomical planes to work on lower limb strength and endurance. • Cardiovascular exercise involved replicating paddling movements with a stick in sitting or standing and boxing in sitting and standing. **<u>Physical 3 (12 pts/group)</u>** **Able to stand independently, has some gait impairments** • The focus of this group was to work on strengthening in multiple anatomical planes and improving balance to aid independence with function and walking outdoors. Sticks were used as a visual and sensory aid to maintain upper body extension during squats. • Cardiovascular exercise involved replicating paddling movements with a stick whilst marching and boxing while marching. **<u>Seated Pilates (8 pts/group)</u>** Participants from Physical 1 and 2 groups. Participants are unable to get on and off the floor and/or have levels of ability that would better suit seated Pilates. The aim of these sessions are global range of movement and strengthening with a particular focus on core activity to aid functional recovery.

		Lying Pilates (8 pts/group) Participants from Physical 3 groups who are able to get on and off the floor and have levels of ability that would suit lying Pilates. The aim of these sessions are global range of movement and strengthening with a particular focus on core activity to aid functional recovery. **Upper Limb Groups** Upper Limb groups were run as joint sessions by a Physiotherapist and Occupational therapist. The focus of these groups was helping participants and carers to learn upper limb rehabilitation and functional task practice principles so they can effectively self manage at home. **Upper Limb 1 (*6 pts/group)** **Participants have minimal activity in affected arm** Sessions and exercises were based on individual needs with common goals being range maintenance, sensory retraining and education on techniques, dose and adjuncts to promote recovery. The overarching principle of Upper Limb 1 sessions was 'keeping the arm in the game' as natural recovery occurs. **Upper Limb 2 (*6 pts/group)** **Participants have beginnings of functional reach in affected arm** Sessions and exercises were based on individual needs working on repeated task practice, strengthening, sensory retraining and education on techniques, dose and adjuncts to promote recovery. The overarching principle of Upper Limb 2 was to work on proximal strengthening and functional reach, whilst promoting distal activity within a function task practice framework. **Upper Limb 3 (*6 pts/group)** **Participants have the beginnings of grasp and release in affected arm** The overarching principle of Upper Limb 3 Sessions was to improve the use of the hemiplegic arm in function based on individual needs. Treatment sessions involved education, repeated task practice and advice regarding strengthening and sensory retraining. **TALKING THERAPY GROUPS** **Meet the team/Me My Stroke and Us (upto 12 pts/group)** **All participants start with this Meet the doctor session and then receive 4 Me My stroke/Brain injury and Us/** • The first session was psychoeducation about what a stroke/brain injury was and what type of brain injury they had. This included learning about having a bleed or a blockage and giving people the language to describe and

understand their brain injury to others especially their family. This session also included information and answering questions about the risk factors for stroke (mainly) and how to prevent future ones. Much of all these sessions addressed worried about recovery and duration of disability.

- The second session involved the physical changes after brain injury. This included things such as hemi-paresis, pain management, balance issues, shoulder pain etc. These were often common concerns among patients. Another area covered was how much to push oneself in the Physical groups.
- The third session covered aspects of cognitive changes after brain injury. These sessions discussed difficulties with attention, communication, memory, executive functioning and visual-spatial difficulties. It covered what these changes may mean in everyday life and how fatigue plays a role in this. Any specific or unusual concerns led to someone being referred for a 1:1.
- The fourth session covered the emotional impact of the brain injury both for the patient and their carer/family. This included changes to motivation

Meet the doctor (upto 12 pts/group)

One of the 'meet the team' sessions

- An open discussion/psychoeducational session on a variety of topics relating to stroke (e.g. causes, prognosis and prevention), rehabilitation (e.g. recovery trajectories, plasticity), or any medical question the participant may have.
- Sometimes followed up with a 1-2-1 assessment session or referral to a relevant service.

Emotional support (6 pts/group, 8 sessions*)

- For people who were experiencing changes to their mood and this was impacting negatively on their work, recovery or relationships. Every session had a theme and Acceptance and Commitment Therapy (ACT) was used. Every session had a similar structure.
- Emotion check in
- Mindfulness exercise
- Session topic introduction
- Discussion and personalised activities
- Goal setting

Session Topics included:

- Increasing self-awareness of mood changes
- Impact of mood on self and others
- Mindfulness and adjustment
- Increasing compassion
- Exploring grief for loss

		• Increasing acceptance through values
		• Creating identity based on values
		• Consolidation, self-management and future goals
		
		<u>Cognitive Rehabilitation (6 pts/group, 6 sessions*)</u>
		
		Anyone referred for changes in cognitive function or thinking skills that was having negative impact on daily living.
		
		Each session followed a similar format.
		• Check in
		• Goal review
		• Session topic introduction
		• Discussion and personalised activities/group activities
		• Goal setting
		
		Session 1: Setting the Scene
		• Rule setting/boundaries of the group
		• Introduction to Cog rehab
		• Insight and awareness building
		• Patient stories:
		  ○ What is cognitive rehab?
		  ○ Why are you here?
		• Bringing in a carer and getting collateral.
		
		Session 2: Routine and Structure/Sherlock Holmes
		
		• What is the importance of routine and structure/ how we create a routine. What helps? What sends us astray?
		• How we prioritise our activities e.g. are you exercising in the morning and unable to carry out cognitive tasks in the PM.
		• How we measure this and getting feedback from others e.g. diary, video diary, family and friends (if safe), appropriate if work colleague
		• Introduction to the importance of goal setting e.g. mastery and increasing confidence, breaking the big goals down.
		• Homework: Write down 3 goals (even if aspirational).
		
		Session 3: Attention/memory and recap Goal Setting
		
		• Check and reflect on homework
		• Different types of memory
		• Sometimes an attention problem (encoding, laying down the memory, recalling, retrieving and recognising)
		• Working memory: stop attend
		• Break tasks down into small chunks
		• Leave a task if getting overwhelmed or anxious
		• Have a 'clean' environment. Set your tasks that are achievable to get early success and remove external distractions. Notice internal distractions (fatigue, mood)
		• Introduction to smart goals and why some goals are successful etc.

		• Homework: Set Smart goal
		
		Group 4: Problem solving strategies
		
		Key message, getting better has an element of risk
		
		• Identify the problem/task
		• Categorise the task into high medium and low priority
		• Break down the tasks into small chunks
		• Get feedback to increase confidence or highlight inefficiencies
		• Test yourself in a safe environment
		• Make sure you're prepared
		• Consolidate your learning
		  ○ What went well
		  ○ what was difficult
		• Praise yourself when you do something well (not just when you achieve something but when you attempt it!!)
		• Don't get overwhelmed by the task and try not to avoid however understand your limitations
		
		Group 5: Identity and Responses to change
		
		Key message, how we feel about our losses in cognition can influence our recovery
		
		• How we interpret the difficulty in a task can lead to frustration and this can impair our concentration and motivation to try it again (we also mentioned that sometimes leaving the task before we get too frustrated can be a good strategy).
		• How we are and behave in the world makes up our identity and how we feel about ourselves. This can be something that we that we are good at e.g. people's names, paying attention, writing emails.
		• When we lose some of these then it can be destabilising and frustrating.
		• Feedback is really important so we can update our recovery and our sense of self.
		• However, who gives us the feedback and how is important. So if your family member is overly critical then this can impact on our mood and confidence and therefore motivation.
		• Setting small and achievable goals should mean that we get good feedback and hear praise.
		• It is sometimes difficult to hear good things about ourselves so be mindful of when someone says something
		• Homework
		• Set a small achievable goal to complete or work towards by next Thursday.

		Group 6: Pre-vocational and planning for the future
		
		Key message, reinforcing the need for structure and daily routine
		
		• Pre-vocational issues e.g. work-hardening
		• Problem Solving:
		  ○ task analysis (break down task into steps)
		  ○ Set goals for this task
		  ○ Get someone to feedback or reflect with you on this
		  ○ it's about becoming more efficient
		  ○ Routine and structure are a huge part of working so we need to establish this.
		
		<u>Caring café (6 pts/group, 6 sessions* and then continued support)</u>
		
		This is for carers only, no patients allowed. This ran as a closed group for 6 sessions and then was offered as a drop-in fortnightly session which was less structured and emphasised more peer support.
		
		Session topics included:
		
		• Changing role
		• Hypervigilance and overprotectiveness
		• Feelings of Loss
		• Caring compassion fatigue
		• Perceptions of recovery/managing expectations
		• Relationship dynamic changes e.g. Carer V's wife/husband/daughter
		• Managing behavioral conflicts
		• Increasing acceptance by adaption and re-evaluating
		
		<u>Fatigue (4 pts/group, 3 sessions*)</u>
		
		This group was for people who had been referred with fatigue or were identified in the Me My Stroke/brain injury and Us group.
		
		Session topics included:
		
		• What is fatigue?
		• Your energy levels/activity tolerance
		• Sleep hygiene
		• Progressive muscle relaxation
		• Budgeting energy
		• The toolbox approach:
		• Delegation
		• Prioritisation
		• Pacing
		• Grading
		• Organisation and planning
		
		<u>Communication (4 pts/group, 3 sessions*)</u>
		
		There were 3 communication groups. Each session included some psychoeducation about the problem and then introduced strategies specifically for each person to try out. The sessions always included

		numerous tasks to put these strategies into practice in both a structured and free practice way. Home work for the week was given and reflected upon in every session. **Dysarthria** Session topics included • What is dysarthria • How does normal speck work? • Strategies to help make my speech clearer • What strategies help me best? • Reading and discussion exercises • Task practices to utilise strategies **Cognitive communication** • Session topics included • Warm up exercises • Contribute and encourage • Looking at communication style • Different types of narrative • Procedural narrative • Being concise • Staying on track • Organising my ideas • Explaining coherently • Finding the right words • Listening and following others **Aphasia** Session topics included: • About Aphasia - what is difficult / what is ok • Describing tasks • Why are finding words difficult? • What helps and what can you try? • Telling stories • Practicing expressing my opinion and using strategies • Strategies for word finding • Keeping talking **INDIVIDUAL SESSIONS** Ad hoc sessions for participants who needed specific input not possible/not appropriate to provide in a group session.

5.	Who (provider)	• 1 x Clinical Neuropsychologist (CNP, band 8b) with supervision provided by a senior, external neuropsychologist. The CNP was funded to work on N-ROL full time.
		• 1 x Neurophysiotherapist (NPT, band 7) was funded to work on N-ROL full time.
		• The CNP and NPT were responsible for project managing N-ROL, designing groups and collaborating on designing groups, liaising with community teams, running groups and the supervision of volunteers. In addition, these professionals presented the N-ROL caseload to Consultants at a weekly Clinical Governance meeting. The CNP and NPT co-ran the NROL introductory sessions to ensure there was a 'face of NROL'. It was hoped this helped participants feel a connection with core team, and they would then know who to contact when they had queries.
		• The CNP was additionally responsible for managing psychological risk of the participants and identifying psychological distress best treated in a 1:1 intervention.
		• The NPT was additionally responsible for conducting 1:1 sessions to help participants manage pain or other functional barriers that were impacting on their participation in physical sessions. Common pain complaints were shoulder pain, lower back pain and hip pain particularly in the hemiplegic side. 26% of the NROL participants required additional 1:1 Physiotherapy sessions.
		• 2 x Neurology Consultants (0.2 FTE in total) oversaw N-ROL. They shared the responsibility of chairing virtual board rounds once a week to allow multidisciplinary discussion of current patient management and to ensure good Clinical Governance. The consultants shared the responsibility of attending the 'Meet the Doctor' sessions.
		• 1 x Technician (volunteer, full time). The technician's role was:
		  ○ To ring any patients who needed technical support to connect to Zoom and ensure they could join the sessions.
		  ○ To send out individual weekly timetables with session-specific hyperlinks for each participant.
		  ○ To call participants on the day of each session to remind them of upcoming sessions that day.
		  ○ To monitor sessions in real time to help with any ongoing technical problems experienced by patients. This ensured treatment sessions could continue for other participants whilst the individual problems were solved.
		  ○ To track attendance rates and document reasons for missed sessions
		• Clinical sessions were delivered by the Clinical Neuropsychologist and Neurophysiotherapist described above plus additional staff, who worked on N-ROL in addition to usual NHS duties:
		  ○ 0.4 WTE Neurophysiotherapists (band 7/8).
		  ○ 0.7 WTE Neuro-occupational therapists (band 7/8).
		  ○ 0.3 WTE Speech and language therapists (band 7).

		• Neuro-occupational therapists who were working from home during the Covid-19 pandemic performed initial patient screening (0.4 WTE Neuro-occupational therapists, band 7). • Non-clinical scientists (3 volunteers) conducted the post-N-ROL outcome measures. Each worked for 1 day a week during the final 2 months of N-ROL or on an adhoc basis as participants were discharged. • Administrator (0.2 FTE, Band 4) whose role was to ensure patient appointments were logged on the electronic notes system for the upcoming week. This allowed treating therapists to be able to input notes for each participant as they attended their sessions.
6.	How	• Referrals were made by filling in a referral form and sending to the N-ROL team at UCLH. • Initial screening of referrals was completed by the core NROL team. The patients that met the inclusion criteria on paper were then screened by Neuro-occupational therapists (band 7). Patients were given information on the service to ensure informed consent, suitability and willingness to participate in online group interventions. The screening proforma was completed as a notes entry on the UCLH Trust electronic patient records (EPIC). This ensured treating therapists were easily able to access screening, safety and contact information on a secure patient notes system. • Initial outcome measures (SSEQ and NROLOM) were also collected via access online *Zoom* platform to ensure the participants were able to access the platform and visual aids could be used to ensure participants understood scoring options. If there were any problems then a 1:1 was booked with the technician prior to any groups. This was aimed at preventing any anxiety when attending groups and preventing delays to start times. • New patients were booked into 'Meet the doctor' and subsequent Stroke education groups ('Me My Stroke and Us') which also acted as another form of triage for other groups. • Patients were triaged into appropriate treatment groups. Individual weekly timetables were created by the two project managers and the technician (3 hours/week). Timetables containing individual session-specific hyperlinks were sent to each patient by email weekly. • Group and individual sessions were conducted online using Zoom. Participants were phoned (or texted according to personal preference) on the day of each session to remind them to attend. Bi-Weekly strategy meetings were attended by the core team (project managers, technician and consultant neurologists) to discuss recruitment, service development, staffing and governance.

		• Weekly clinical governance team meetings (core team and other therapists) were conducted to discuss all participants, their progress and any concerns.
7.	Location	• All patients and carers participated online from their own homes or from work. • Therapists delivered treatment groups online either from their own home, or from one of two 'studios' set up in UCL research labs. One large room (5mx18m) was used for 'physical' sessions; one smaller room (4mx5m) was used for 'talking' sessions. Each studio contained a desktop PC connected to the internet by ethernet cable, webcam, speakers. The PC in the physical studio was connected to a 54 inch TV monitor. • Project managers and technician were housed together in open plan office space, allowing for social distancing.
8.	How much	Each session lasted between 45 and 60 minutes. The following groups had a fixed number of sessions representing a full course of treatment: • Meet the team/Me My Stroke and Us: All participants started with the Meet the doctor session, followed by 4 'Me My Stroke/Brain injury and Us' sessions. Emotional Support Groups: 8 sessions • Cognitive Rehabilitation Groups: 6 sessions Fatigue Management Groups: 3 sessions • Communication Groups: 6 sessions Carers Café Groups: 6 fixed sessions plus additional follow up if required • Upper Limb Groups: Length of participation varied between 1 and 6 sessions depending on clinical need. However groups were closed according to shared goals and ability levels. The following groups had an open ended policy • Physical Fitness: Length of participation varied between 4 and 55 sessions depending on clinical need. We acknowledge that the optimal number of groups that constitutes an appropriate course of treatment is arbitrary and is determined by the relationship between demand and resources. Some groups have a limit on the number of participants (e.g. all of the talking therapies), whilst physical fitness groups with patients who have mild impairment were able to accommodate a greater number of participants. The optimal number per group and optimal number of sessions remains unclear.

		For our cohort: • median sessions per patient = 27.1 • median patients per session = 5.4 • median days in the service = 70 • median number of unique groups joined = 4
9.	Tailoring	• Upper Limb sessions were adapted to patients' functional needs. • Patients in the Physical Fitness and Pilates sessions were stratified into one of 3 groups based on ability (determined at triage and subsequent performance in groups). Each group addressed common mobility goals expressed by participants within each level. As participants expressed additional functional needs these were either incorporated into the content of the sessions or addressed within 1:1 sessions by the NPT. • Talking therapies were closed groups where similar content was adjusted to meet the needs of the group members. • As N-ROL is primarily based around groups of patients, therapists could tailor by matching patients within each group in order to achieve balance for factors such as severity. • Sessions might be tailored to a group of patients e.g. several patients in a cohort suffered from dysarthria, so the SLT set up a few dysarthria sessions. • Sometimes patients need individualized sessions and we ran occasional one to one sessions for problem solving (e.g. painful shoulder, visual or reading problems, incontinence, psychological risk, carer burden, uncertainty about group membership suitability).
10.	Modifications	The N-ROL service evolved over time. • New sessions: session development was mainly dependent on having certain types of therapists available, e.g. when we started N-ROL, there were no SLTs available due to Covid redeployment. When they became available, we were able to add in SLT groups. • Content modification: occurred frequently and was driven by individual therapists in response to their learning how best to run remote therapy groups. In our Meet the Doctor/Team sessions we encouraged people to ask about any part of their stroke recovery. Topics covered evolved to include causes of stroke, rationale for medication, the meaning of test results, return to work, pain, fatigue, bladder symptoms, their need for vocational rehabilitation, problems with pain or fatigue, mechanisms of recovery after stroke, discussion of how long recovery can continue.

		• At the end of the 6-months we conducted single education workshops on popular topics such as Vocational Rehabilitation, Upper Limb Rehabilitation Principles, Shoulder Pain and Fatigue Management which included signposting people to other services. These were particularly relevant to people who had accessed the service later in the project and had not been able to access some of the closed groups. However, we advertised them to all participants as some people appreciated a refresher of information. • The Physical group was generally responsive to the goals and abilities of the participants at any one time. Later on the N-ROL, Physical 3 groups were split into higher and lower intensity groups to cater for people who wanted more vigorous activity level as their cardiovascular fitness progressed. • <u>Process modification:</u> included improving the process of timetabling (performed by the therapy team on Friday afternoons). Our goal was to email the next week's timetable and session links to all individual patients and their careers with hyperlinks to each individual session. We recommend having clear timetabling templates with hyperlinks embedded. We optimized and streamlined the process using spreadsheets in Microsoft Teams so all team members could view and edit documents in real time. We also tallied up all timetables as they were sent out to ensure no patients were missed (we had over 70 timetables per week to send at our peak). In addition, to help participants with planning their week we ensured each day on the timetable that a patient needed to attended an NROL session was highlighted in yellow. • <u>Physical group muting:</u> Initially all participants were muted after an initial greeting period. However, during NROL participants expressed the need to have some time at the end of sessions to sign off and to ask questions and so unmuted periods at the end of groups was introduced as a modification.

11/12	How well (planned)	In order to ensure patients attended their sessions, they were called by a volunteer to remind them of sessions and help with session preparedness.
		
		<u>Attendance:</u>
		• During these calls participants were able to disclose if they were unable to attend (UTA) a session or give reasons why they had previously missed sessions. Our overall session UTA rate was 28%,
		• Out of 185 logged UTA reasons the top 65% were as follows:
		  ○ Attending remote Hospital/GP appointment (15%)
		  ○ Too Busy - organising work or life administrative commitments (18%)
		  ○ Forgot (14%)
		  ○ Too tired (10%)

		○ Clash with Community therapy face to face appointment (8%). These phone calls enabled the volunteers to ask participants about their expectations for the Physical and Talking therapy sessions. <u>Pre-programme goals:</u> • Examples of common Physical goals were improving mobility, balance, falls prevention and being able to get on and off the floor. In addition, arm recovery was often a high priority especially in relation to specific functional tasks. Patients also commented on specific impairments such as pain, spasticity and dropped foot that were impacting on their function. • Example of talking therapy goals were speech recovery and improved confidence in conversations, improved fatigue management, returning to work and improved attention when attempting life tasks. • Examples of Carer goals were having time to reflect on common struggles with other carers and gaining information how to better support their relative or partner. <u>Within programme feedback:</u> • Participants were also asked if they felt the Physical sessions were set at the right level for them. Generally, we found participants were happy with their level but 3 participants wanted to be moved up at various points as they felt they could work harder in sessions. Also this allow participants to ask for specific 1:1 sessions for problems such as pain or specific personal goals. <u>Feedback:</u> • When participants were ready for discharge from NROL, as well as completing outcomes measures, they were asked to comment on whether the program met their needs. These comments have formed part of a qualitative analysis. • Participants and carers were asked to indicate their agreement with the following statement 'I would recommend NROL to friends and relatives' on a 5 point Likert scale: ○ 59 strongly agreed ○ 8 agreed ○ 4 didn't answer that question, ○ 4 didn't complete post outcomes ○ 1 disagree (this person only attended 1 introductory group) <u>Content Quality:</u> • All therapists delivering content had experience in delivering outpatient face to face versions of the sessions. Often presentations and written content was previously written and used in prior outpatient clinics. • We did not have written instructions for therapists to learn how to deliver sessions, rather new therapists would join in with an established therapist to 'learn on the job' how the session ran. In general, we found, for the Talking sessions were best run with

		two therapists whereas Physical sessions could be run by individual therapists. • The following outcome measures were used by N-ROL therapists according to individual participant needs: The Therapy Outcome Measure (TOMS), Self rated confidence in conversation, Self rated pain on movement of upper limb, Modified Fatigue Impact Scale, Fatigue after Stroke Scale, Physical Activity Vital Sign (PAVs), Upper Limb ArmA A and Upper Limb ArmA B. These were part of individual participants care and related to specific groups participants attended. They did form not part of the suite of outcomes completed by all participants who participated in the N-ROL project. <u>Referral base:</u> • N-ROL was initially set up to treat patients with acquired brain injury who had been discharged from hospital in the last 6 months, as we reasoned that these patients were receiving less rehabilitation treatment than usual because of the effects on clinical services due to the Covid-pandemic. We also initially limited our referrals to patients in the North Central London Sector. We made efforts to advertise the service to the appropriate referring clinicians/therapists, but inevitably this took time. • In order to ensure that we were operating at or near capacity we monitored referral rates. We quickly broadened the geographical catchment area for referrals. In total 66% of our referrals were from the North Central London sector, and 34% from elsewhere. We note that the nature of telerehabilitation means that patients can be treated in any location. <u>Time since injury:</u> • In order to get the service started promptly, we accepted 8 patients outside of the designated time window (<6 months since injury). However, all of these patients had still suffered withdrawal of community rehabilitation services at the time of referral. We did not include these 8 patients in the final analysis of quantitative outcomes.

Table S2: Activity data for N-ROL programme. CC = Cognitive communication

GROUP	patients treated	total sessions	patient-sessions	sessions/patient	patients/session	% per group
N-ROL TOTAL	86	434	2332	27.1	5.4	100.0
Stroke education and triage	83	55	389	4.7	7.1	96.5
Cognitive rehabilitation	27	24	120	4.4	5.0	31.4
Emotional support	18	24	117	6.5	4.9	20.9
Communication: Assessment	18	7	18	1.0	2.6	20.9
Communication: Aphasia	8	13	30	3.8	2.3	9.3
Communication: CC	17	22	66	3.9	3.0	19.8
Communication: Dysarthria	9	19	49	5.4	2.6	10.5
Fatigue management	16	9	43	2.7	4.8	18.6
Carer support	16	24	93	5.8	3.9	18.6
Physical: seated	15	26	152	10.1	5.8	17.4
Physical: supported standing	52	51	380	7.3	7.5	60.5
Physical: unsupported standing	47	59	513	10.9	8.7	54.7
Physical 1:1	22	22	22	1.0	1.0	25.6
Seated Pilates	43	24	135	3.1	5.6	50.0
Lying Pilates	34	21	110	3.2	5.2	39.5
Upper limb: Assessment	7	6	7	1.0	1.2	8.1
Upper limb: severe	8	10	23	2.9	2.3	9.3
Upper limb: moderate	15	8	30	2.0	3.8	17.4
Upper limb: mild	12	10	35	2.9	3.5	14.0

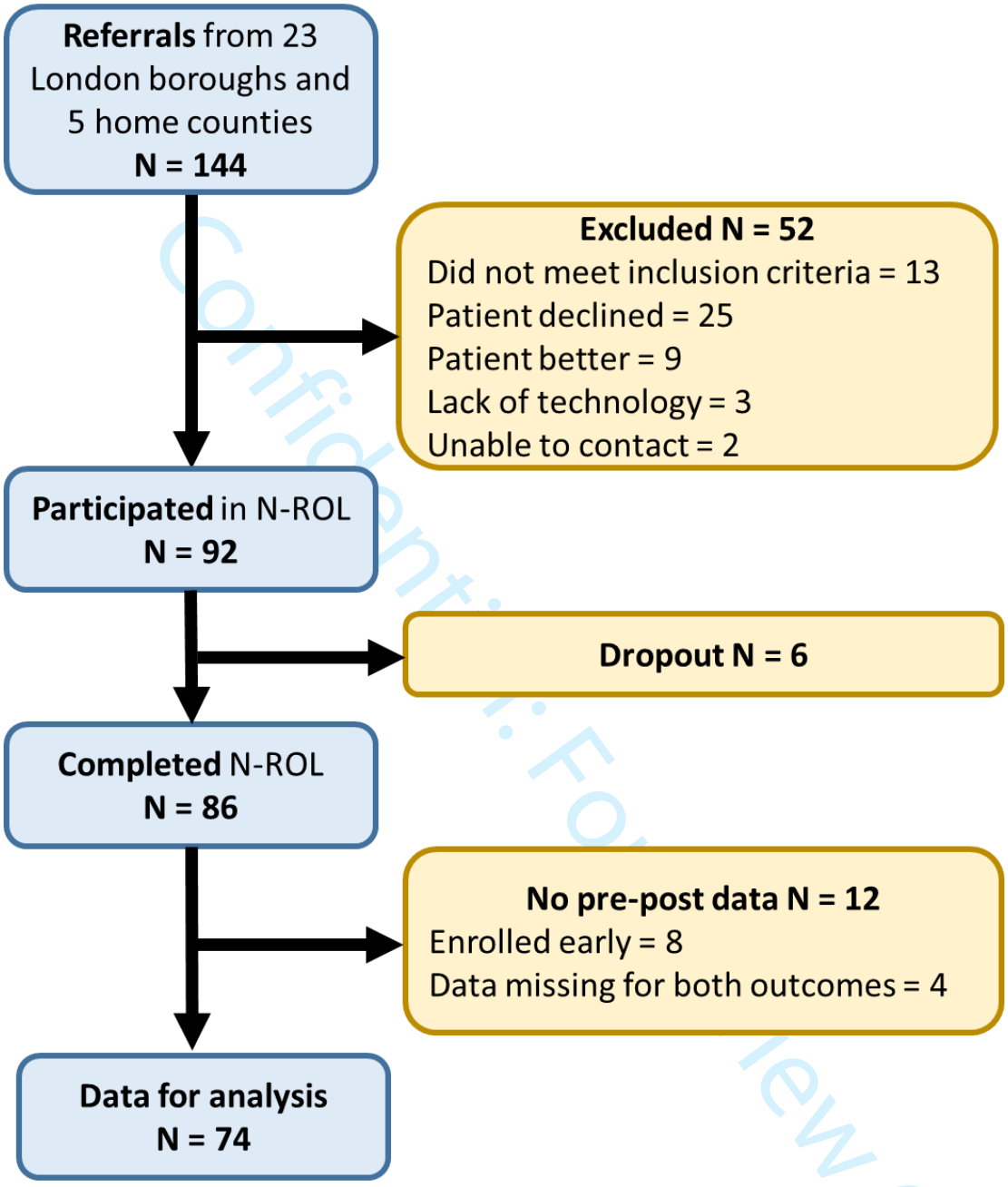


Figure S1 CONSORT diagram

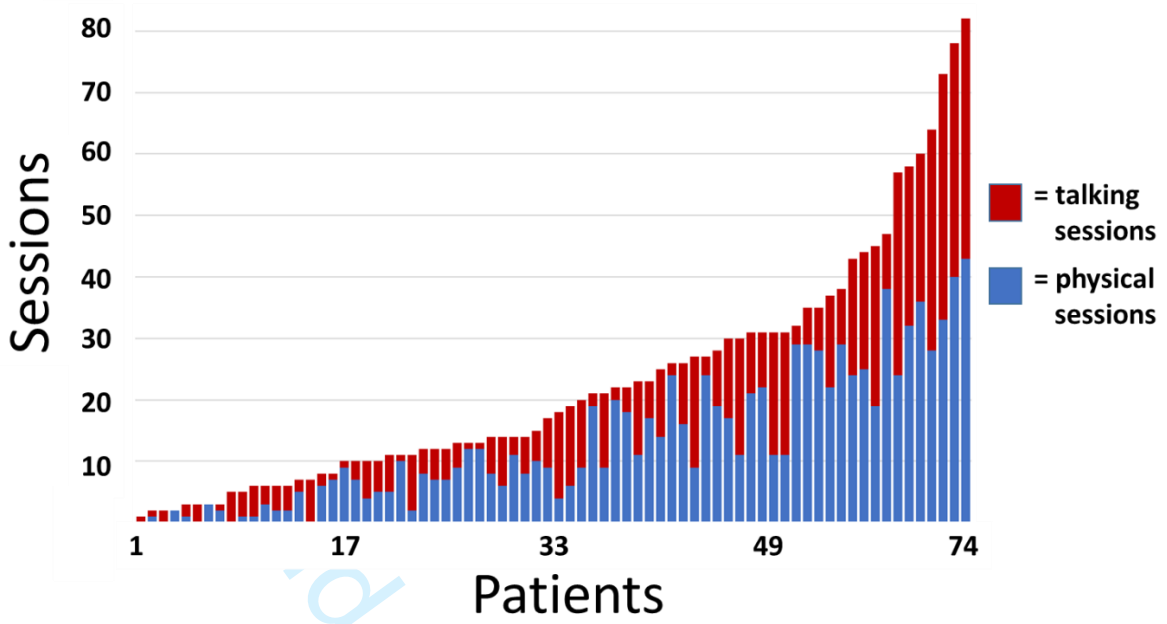


Figure S2 Number and type of sessions undertaken by the 74 patients with complete outcome data (x-axis). Patients are ranked from lowest to highest in terms of total number of sessions attended (y-axis). Talking sessions are in red and physical in blue.

University College London Hospitals NHS
NHS Foundation Trust

The National Hospital for Neurology and Neurosurgery
Neuro Rehabilitation OnLine (N-ROL)

Neuro-Rehabilitation OnLine Outcome Measure

Name: Date: Timepoint: Pre/post

Reviewer to establish two facts before starting the scoring:

1. What was the cause of your acute brain injury?
2. Do you have a carer/family member who lives with you and who would be willing to answer two additional questions (NB: should be done when the patient is not able to hear their responses).

In the context of living with your brain injury/stroke in the pandemic, please tell us how much you agree or disagree with the following statements (then go through the 5 response options)

Questions for the patient

Q1: I understand why I suffered a stroke/brain injury

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

Q2: My day has a clear structure to it

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

Q3: I have a good understanding of what I can do to continue to make progress

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

Q4: I am motivated to work on things that are hard for me to do after my stroke/brain injury

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

Q5: Other stroke/brain injury survivors have helped me understand my own stroke/brain injury

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

Q6: My stroke/brain injury has isolated me from others

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

Q7: I no longer know who I am after my stroke/brain injury

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

TOTAL:

Questions for the Carer

Q8: [my partner's/the patient's] condition makes me feel isolated

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

Q9: I know what I need to do to help [my partner, the patient]

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

TOTAL:

DISCLAIMER This service is not a replacement of community telehealth services. This service will aim to deliver content aimed at different levels of ability: If a stroke survivor feels any content will put them at risk of harm (such as falling) we will ask them to self -limit and skip content as required. Stroke survivors will be asked to contact their local services: GP, Community Team, Social Worker regarding their individual care needs as we will not be able to provide individual support. V2 20_04_2020