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**DOI:** <https://doi.org/10.1136/bmjopen-2021-055946>

**Publisher:** BMJ

**Version:** Published Version

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# BMJ Open Development of strategies to support home-based exercise adherence after stroke: a Delphi consensus

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**To cite:** Mahmood A, Deshmukh A, Natarajan M, *et al.* Development of strategies to support home-based exercise adherence after stroke: a Delphi consensus. *BMJ Open* 2022;**12**:e055946. doi:10.1136/bmjopen-2021-055946

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-055946>).

Society of Indian Physiotherapists Conference 2018

Received 30 July 2021

Accepted 10 December 2021

## ABSTRACT

**Objective** To develop a set of strategies to enhance adherence to home-based exercises after stroke, and an overarching framework to classify these strategies.

**Method** We conducted a four-round Delphi consensus (two online surveys, followed by a focus group then a consensus round). The Delphi panel consisted of 13 experts from physiotherapy, occupational therapy, clinical psychology, behaviour science and community medicine. The experts were from India, Australia and UK.

**Results** In round 1, a 10-item survey using open-ended questions was emailed to panel members and 75 strategies were generated. Of these, 25 strategies were included in round 2 for further consideration. A total of 64 strategies were finally included in the subsequent rounds. In round 3, the strategies were categorised into nine domains—(1) patient education on stroke and recovery, (2) method of exercise prescription, (3) feedback and supervision, (4) cognitive remediation, (5) involvement of family members, (6) involvement of society, (7) promoting self-efficacy, (8) motivational strategies and (9) reminder strategies. The consensus from 12 experts (93%) led to the development of the framework in round 4.

**Conclusion** We developed a framework of comprehensive strategies to assist clinicians in supporting exercise adherence among stroke survivors. It provides practical methods that can be deployed in both research and clinical practices. Future studies should explore stakeholders' experiences and the cost-effectiveness of implementing these strategies.

## INTRODUCTION

Stroke is one of the leading causes of death and disability across the world.<sup>1</sup> Rehabilitation is recommended to promote recovery, enhance independence and improve quality of life after a stroke.<sup>2 3</sup> However, healthcare services and comprehensive stroke rehabilitation centres are often expensive and beyond people's reach.<sup>4 5</sup> Considering the limited access to hospital-based healthcare services after stroke,<sup>4</sup> home-based rehabilitation is often preferred and sometimes the

## Strengths and limitations of this study

- The multidisciplinary expert panel consisted of specialists in exercise prescription, behavioural science and community medicine, each having diverse experiences that contributed to the development of this multi-faceted framework of strategies.
- We developed strategies specific to low-income and middle-income countries that are affordable and provide practical methods of implementation.
- One of the limitations of this study was that the individuals with stroke and their caregivers were not included in the Delphi panel.
- There was an unequal representation of experts from different specialities.

only option for stroke survivors living in low-resource settings.<sup>6 7</sup> Home-based rehabilitation has been shown to have functional and cost benefits.<sup>8 9</sup> Adherence to the home-based regimen is of utmost importance for any intervention to be beneficial.<sup>10 11</sup> Improving adherence to exercise programmes after stroke has been shown to improve functional recovery.<sup>12</sup>

Non-adherence to physical exercises is a common problem among stroke survivors.<sup>13</sup> The level of adherence to prescribed home-based exercises among Indian stroke survivors was found to be only 28%.<sup>14</sup> Barriers to exercise after stroke include factors at the individual, interpersonal, organisational and community levels.<sup>15</sup> Modifiable factors include lack of knowledge about stroke, lack of supervision and motivation, and inadequate exercise prescription by healthcare providers.<sup>15–17</sup> Other factors that impact adherence include pain, fear of falls and post-stroke fatigue.<sup>18 19</sup> In addition, environmental factors such as cost, accessibility and transport are other barriers for people with chronic



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stroke. Thus, developing effective strategies that reinforce adherence to home-based exercises is important.<sup>19</sup> As stated by the WHO, ‘increasing the effectiveness of adherence interventions may have a far greater impact on the health of the population than any improvement in specific medical treatments.’<sup>20</sup> Therefore, improving adherence to post-stroke rehabilitation may enhance recovery and improve the quality of life among stroke survivors.<sup>21</sup>

Exercise adherence can be improved through motivational interventions, behavioural change strategies, multimedia, follow-up sessions, feedback, cognitive-behavioural therapy, skill training, self-monitoring, goal setting, coping strategies and coaching.<sup>21–23</sup> However, there is limited information on how to practically incorporate these into clinical practice. Therefore, developing strategies for promoting post-stroke exercise adherence is essential.<sup>12–24</sup> Identifying barriers affecting adherence to exercise, and developing strategies that can be practically implemented by stroke survivors to modify those barriers, increases the potential for improving exercise adherence.<sup>25</sup> Thus, we aimed to develop a set of strategies to facilitate adherence to home-based exercises after stroke and a comprehensive framework to classify these strategies.

## METHODS

This study was a part of a doctoral thesis that was conducted in four phases. In the first phase, we measured the level of exercise adherence among community-living stroke survivors. In the second phase, we conducted qualitative interviews with stroke survivors to understand the factors affecting exercise adherence. Using the themes derived in the second phase, a Delphi study was conducted in the third phase to develop a framework of strategies to support adherence to the home exercise programme. The fourth phase involved testing the effectiveness of the developed framework of strategies in a pilot randomised controlled trial. The methods and findings of phases I, II and IV are published elsewhere.<sup>14–15–26</sup> The current study (Delphi consensus) describes the process and findings of the third phase of the project.

### Participant recruitment

Participants (experts) were recruited using purposive sampling. The criteria for selection were: (1) expertise in stroke/behavioural change/community health, (2) having more than 10 years of clinical experience, (3) published in peer-reviewed journals, (4) involvement in translational and collaborative health research, and (5) employed in academia, research or clinical practice.

We identified the experts through the collaborative network of the Centre for Comprehensive Stroke Rehabilitation and Research at the Manipal Academy of Higher Education. We aimed to recruit a majority of experts from India to ensure suggestions were context-specific to low-income and middle-income countries. We

invited experts to participate in the study from different fields (physiotherapy, occupational therapy, neurology, clinical psychology, community medicine and behaviour science) to ensure that the strategies were comprehensive and covered multiple aspects of adherence.

Experts were invited via email. Those who agreed to participate gave their written consent and were included in the study. We conducted a four-round Delphi consensus; two online surveys, followed by a focus group to build a set of adherence strategies for home-based exercises based on survey results, then a final online consensus round.<sup>27</sup> Each round took 2 months. Experts were sent two reminder emails and any non-respondents were excluded from that round. Except for the focus group, the experts were blinded to each other for all rounds, and responses were anonymous. The Delphi rounds were conducted between January 2018 and December 2018. The primary investigator, an experienced stroke physiotherapist (AM) collected and analysed the data. The focus group was conducted by another investigator (JMS) who has more than 15 years of experience in neurological rehabilitation and qualitative studies.

## Data collection and analysis

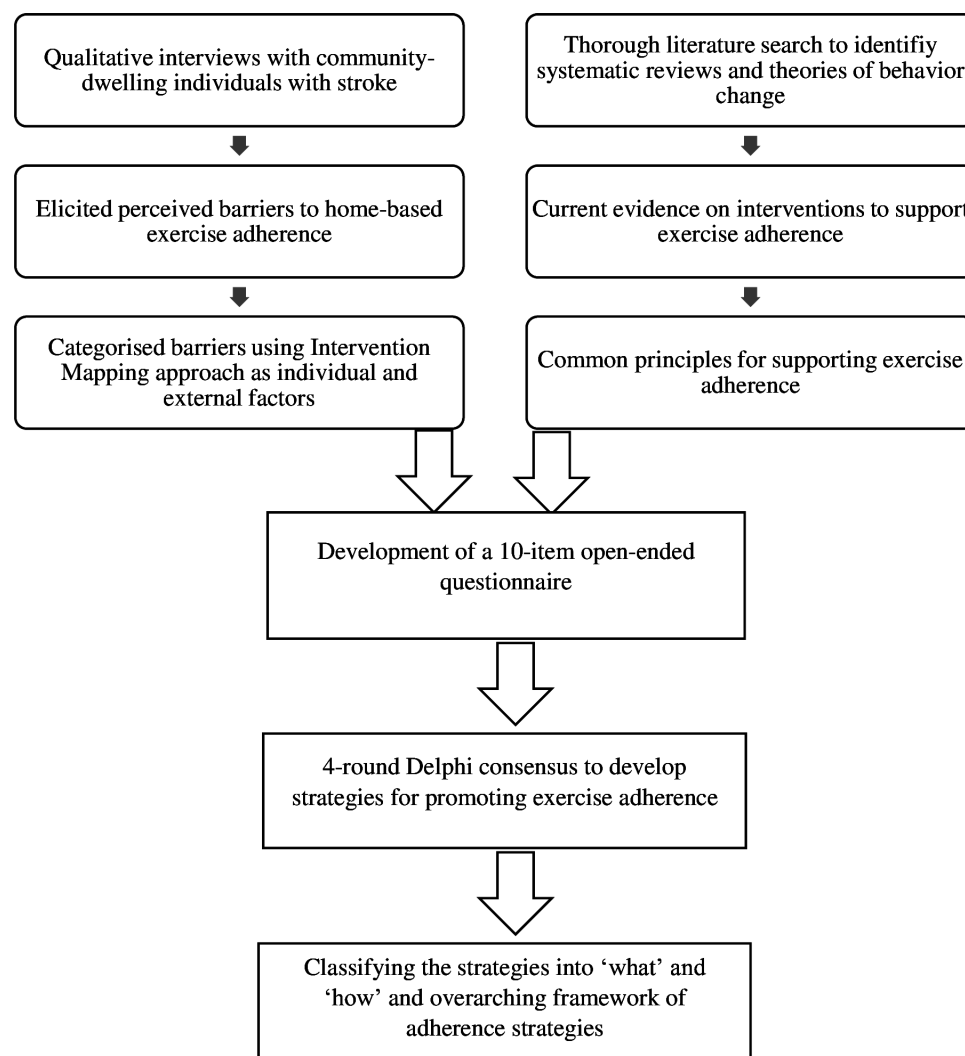
### Round 1

Our previous study explored factors influencing adherence to home-based exercises among stroke survivors through in-depth interviews.<sup>15</sup> Using this information, we categorised the barriers reported by the stroke survivors into internal and external factors using the Intervention Mapping approach.<sup>25</sup> We also performed a literature search in PubMed, Scopus, Web of Science and Cochrane using the search terms “physical exercises,” “adherence,” “compliance,” “behavior change,” and “health behavior.” We reviewed studies from the bibliographies of the relevant articles. We identified health behavioural change theories and existing strategies/interventions used for improving adherence to long-term therapies. Our review of the literature identified common principles for supporting adherence such as motivation, self-efficacy, social support, the role of family, online health support (mHealth) and behavioural change techniques.<sup>27–34</sup> Our findings from the literature and our qualitative study were combined to form a 10-item survey using open-ended questions in SurveyMonkey software (<https://www.surveymonkey.com/>). The survey was then emailed to the expert panel (online supplemental file 1).

We merged the experts’ written responses to perform content analysis<sup>35</sup> and coded the responses using ATLAS.ti V.8 software. The responses that were suggested by more than nine out of 13 (70%) experts were considered as ‘certain strategies’. Responses that were not common and suggested by less than nine experts were labelled ‘uncertain strategies’ for further consideration in round 2.

### Round 2

The second survey, consisting of only the ‘uncertain strategies’, was emailed to the expert panel, and they



**Figure 1** Process of development of adherence framework.

were asked to agree/disagree on the given strategies and provide reasons for their opinion. For an ‘uncertain strategy’ to become a ‘certain strategy’, it needed to have a majority agreement, that is, 6 out of 11 experts. This process resulted in a final set of 64 strategies.

### Round 3

We then conducted a face-to-face focus group to collate the included strategies into broader categories. The expert panel was asked to categorise the list of strategies into a specific domain. They also suggested practical ways of implementing the suggested strategies such as: who should design it, the content, how it should be delivered and target stakeholders. Any experts who could not be present at the focus group were emailed the categories and asked to evaluate the draft framework.

### Round 4

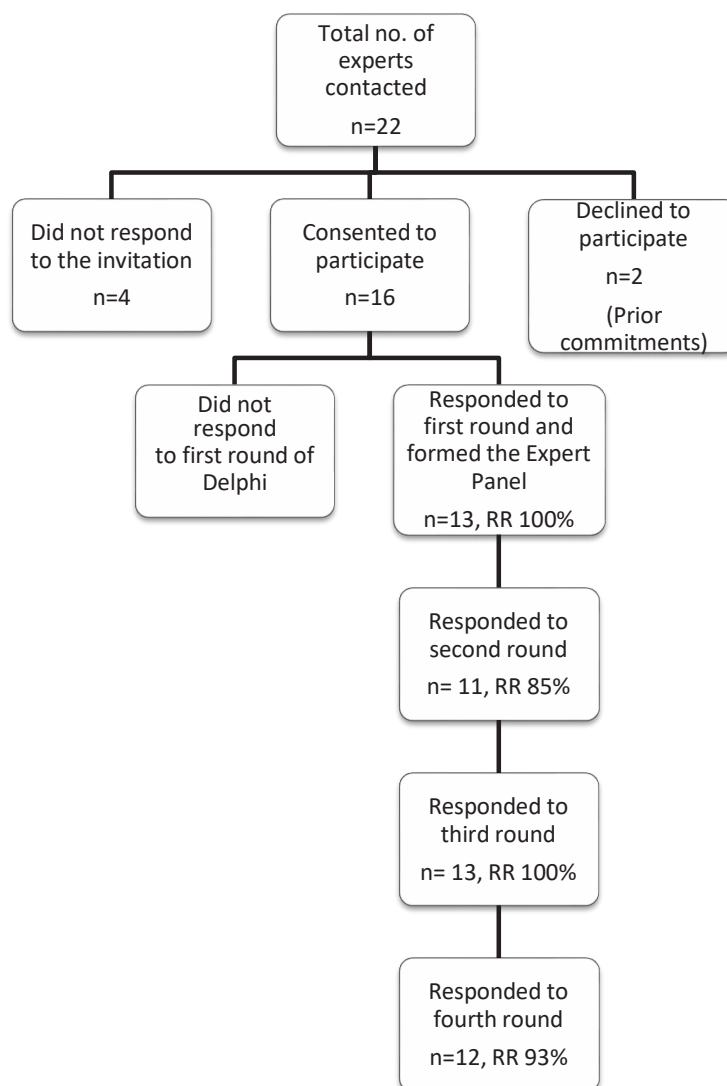
The framework of strategies was sent to all the experts for minor modifications and approval. The consensus from the experts led to the development of the final framework. [Figure 1](#) shows the development of the framework.

### Patient and public involvement

While this Delphi study was conducted among subject experts; opinions of patients and caregivers were used to develop the open-ended questions included in the first round of the Delphi process. Qualitative interviews were conducted among community-dwelling stroke survivors to explore their exercise behaviour and barriers to exercise adherence in the second phase of this project. The patients’ opinions highlighted that not only patient-related factors, but family, healthcare system and community-level factors played a role in exercise non-adherence. This information was used in the development of open-ended questions that were included in the first round of the Delphi process. Therefore, the patients’ perceptions and needs were incorporated in this study for designing adherence strategies and framework.

### RESULTS

We invited 22 experts across India and abroad to participate in the Delphi survey. Thirteen consented



**RR: Response rate**

**Figure 2** Flow of participants and response rate in each round.

to participate in the study and responded to round 1 (figure 2). The final panel consisted of physiotherapists (n=7), clinical psychologists (n=3), occupational therapist (n=1), behaviour scientist (n=1) and epidemiologist (n=1). Three experts were from Australia, one from the UK, and the remaining experts were from India. Each panel member had more than 10 years of clinical experience and multiple publications (table 1).

### Round 1

The open-ended survey and the summary of responses received in the first round are provided in online supplemental file 1. The content analysis of the responses received in round one yielded a total of 75 strategies. Of these, 50 strategies were suggested by more than nine experts (ie, >70%) and were considered 'certain'. The remaining 25 were considered 'uncertain' strategies

(suggested by less than nine experts) and were included in the next round for further consideration.

### Round 2

The response rate for round two was 85% (11 experts.) More than 60% of experts agreed on 14 out of 25 uncertain strategies and hence those were included. The remaining 11 strategies with less than 60% agreement were excluded. The percentage of agreement for each uncertain strategy is provided in online supplemental file 2. We included a total of 64 strategies (50+14) for the subsequent rounds.

### Round 3

Six experts (three clinical psychologists, two physiotherapists and one epidemiologist) participated in the face-to-face focus group. The remaining seven experts responded

Table 1 Details of participants				
Participants	Qualification	Area of work	Expertise	Country
1	Epidemiologist	Research, Academic	Community and rural health Associated with the WHO, Indian Council of Medical Research and Global Burden of Disease Network	India
2	Occupational Therapist	Clinical	Stroke care and activities of daily living	Australia
3	Physiotherapist	Research, Academic	Stroke rehabilitation and physical activity. Associated with the World Stroke Organisation, Stroke Recovery and Rehabilitation Roundtable and Priority Research Centre for Stroke and Brain Injury	Australia
4	Physiotherapist	Research	Stroke and cardio-respiratory fitness. Associated with the World Stroke Organisation and Priority Research Centre for Stroke and Brain Injury	Australia
5	Physiotherapist	Clinical	Stroke rehabilitation	India
6	Physiotherapist	Research, Academic	Stroke rehabilitation	India
7	Physiotherapist	Research, Academic	Community Physiotherapy, and technology in rehabilitation	India
8	Physiotherapist	Research, Academic, Clinical	Physical activity epidemiology	India
9	Physiotherapist	Research, Academic, Clinical	Stroke rehabilitation	India
10	Behaviour scientist	Research	Behaviour change evidence and theories. Designing and evaluation of behaviour change interventions	UK
11	Clinical Psychologist	Research, Academic, Clinical	Cognitive rehabilitation, behavioural therapies	India
12	Clinical Psychologist	Research, Academic, Clinical	Cognitive rehabilitation, behavioural therapies	India
13	Clinical Psychologist	Research, Academic, Clinical	Cognitive rehabilitation, behavioural therapies	India



via email and provided input to the framework. The final 64 strategies were grouped into nine domains (table 2).

#### Round 4

The final framework of strategies for improving home-based exercise adherence was agreed on by 12 (93% response rate) experts. The experts agreed that the exercise-related strategies should be designed and delivered by therapists having experience in stroke care such as an occupational therapist, physiotherapist, physiatrist or stroke nurse. They suggested that the strategies requiring behavioural techniques should be designed and supervised by a licensed clinical psychologist or behaviour therapist. In the following section, we have highlighted the key suggestions from the expert committee under each domain. The details of the framework are provided in online supplemental file 3.

Strategies for improving adherence to home-based exercises post stroke under each domain

#### Domain I: patient education on stroke and recovery

Experts agreed that the patient education should comprise of: (1) usual time course and speed of recovery, (2) the impact of practice and exercise on recovery, (3) adverse effects of rest and positive effects of activity, (4) the importance of secondary risk factor management, (5) managing complications (e.g., spasticity, pain, fatigue, contracture, depression), (6) complementary medicine (including traditional medicines and religious practices), (7) importance of adhering to the exercise programme, dosage of the exercise programme, (8) role of a caregiver, (9) recovery and return (interaction between severity and prognosis), (10) proper positioning techniques and (11) misconceptions about stroke recovery.

Methods recommended for delivering education included: written information, individual discussions, and phone calls that are individually tailored to each patient's needs, as well as conducting group sessions wherein testimonials from recovered patients and their caregivers are presented.

#### Domain II: methods of exercise prescription

Exercises that are prescribed should be task-specific and individually tailored based on each person's impairments, goals and context. These exercises should be reinforced using demonstration and practice. Exercise prescription should include personalised information or messages of personal encouragement.

Additional ways for prescribing exercises may include written or pictorial instructions, videos of exercises, voice-assisted programme or internet-based applications. Other ways that can support adherence are video recording of patients' exercise performance, splitting the exercise into smaller steps for severe impairments and gradually increasing difficulty level. Gaming or gamification may also facilitate exercise adherence since it gives a sense of achievement and reinforces exercise behaviour.

#### Domain III: feedback and supervision

For regular feedback and supervision, maintaining an exercise log, everyday activity status or updates that are monitored by the medical team could be useful for supporting adherence.

Having therapists clear any doubt that patients might have about their exercise prescription, routinely ask patients about their progress and periodically ask patients to give feedback about the quality of their interaction with therapists will provide a sense of supervision and accountability, thus facilitating adherence.

There should be regular contact with the therapists (in person or via telehealth.) Therapists can use recorded audio/video clips, individual or group discussions for feedback and supervision. Therapists should use standardised assessments to measure clinical outcomes and provide feedback on progress.

#### Domain IV: cognitive remediation

The experts in behavioural science and cognitive rehabilitation agreed on prescribing tasks that are focused on functional recovery, planning the exercise centred on individual goals and understanding the patient's motivation before the treatment session. Motivational interviewing or motivation enhancement therapy could be used to understand their baseline motivational level and establish intrinsic motivation for behavioural change. Providing positive feedback and reinforcement for small improvements engenders confidence in patients. Additionally, having a contingency plan for days when exercises could not be performed would prevent abrupt cessation of the exercise routine. Using behavioural activation (a treatment technique used in clinical psychology for managing depression) so that patients perform one enjoyable activity each day would keep them motivated to stick to their exercise schedule.

#### Domain V: involvement of the family members

Experts suggested that the family should be involved; however, the amount of assistance provided by the family needs to be balanced so as not to promote dependency. Assessing knowledge and understanding of the caregivers on post stroke exercises is crucial for them to reinforce patients' adherence. Family can be involved by being the patient's exercise partners, or by setting up exercise reminders, or by helping track the patient's progress. Demonstrating and practising exercises with family can also enhance the self-efficacy and confidence of caregivers.

Managing the expressed emotions of the family members is important as it may hinder treatment and restrict the patient's autonomy. Rotating family members in the supervision of the patient's activities can help in reducing burnout and maintaining novelty in routine.

#### Domain VI: involvement of society/ community

Family and friends can interact with the patient on topics not concerning the illness (areas of interest to the patient

**Table 2** Grouping of strategies into specific domains

Items	Domains	Strategies
1	Patient education on stroke and recovery	<ul style="list-style-type: none"> <li>▶ Patient education about stroke and its treatment</li> <li>▶ Patient education on adherence</li> <li>▶ Caregiver education and involvement</li> <li>▶ Written instructions and pictures</li> <li>▶ Testimonials from recovered patients</li> <li>▶ Information on support agencies</li> <li>▶ Benefits of exercise</li> <li>▶ Psycho-education</li> </ul>
2	Exercise prescription	<ul style="list-style-type: none"> <li>▶ Written instructions and pictures</li> <li>▶ Videos of exercises</li> <li>▶ Task-oriented training</li> <li>▶ Prioritising on a few tasks at a time</li> <li>▶ Meaningful and relevant exercises</li> <li>▶ Breaking down exercises into smaller steps</li> <li>▶ Individualised programme</li> <li>▶ Fun and engaging exercises</li> <li>▶ mHealth applications</li> <li>▶ Demonstrate and practice exercises</li> </ul>
3	Feedback and supervision	<ul style="list-style-type: none"> <li>▶ mHealth applications</li> <li>▶ Activity log</li> <li>▶ Feedback from patients</li> <li>▶ Feedback on their progress</li> <li>▶ Exercise charts with video/audiorecording</li> <li>▶ Asking to tell approach</li> <li>▶ Clearing doubts by the medical team</li> <li>▶ Regular contact with therapists</li> <li>▶ Recording exercises for feedback</li> <li>▶ Regular monitoring</li> <li>▶ Understand previous exposure with exercises</li> </ul>
4	Cognitive remediation	<ul style="list-style-type: none"> <li>▶ Educating on the benefits of exercise</li> <li>▶ Motivational interviewing</li> <li>▶ Cognitive-behavioural therapy techniques</li> <li>▶ Behavioural activation</li> <li>▶ Contingency charts</li> <li>▶ Involving group sessions</li> <li>▶ Meaningful tasks</li> <li>▶ Psycho-education</li> </ul>
5	Involvement of family members	<ul style="list-style-type: none"> <li>▶ Exercise buddies</li> <li>▶ Emotional support</li> <li>▶ Assessing knowledge and understanding of the family on the importance of exercise</li> <li>▶ Rotate family members in care giving</li> <li>▶ Activity scheduling</li> </ul>
6	Involvement of society	<ul style="list-style-type: none"> <li>▶ Involvement of friends</li> <li>▶ Involving group sessions</li> <li>▶ Modelling behaviour</li> <li>▶ Support and exercise groups</li> <li>▶ Social comparison</li> </ul>
7	Promoting self-efficacy	<ul style="list-style-type: none"> <li>▶ Personal graph charts</li> <li>▶ Reduce the no of alternatives presented to the patient</li> <li>▶ Provide activities that can be done independently</li> <li>▶ Standardised assessment</li> <li>▶ Goal setting</li> <li>▶ Self-efficacy enhancement: using substitution and optimisation principles</li> <li>▶ Ongoing support</li> <li>▶ Methods of tracking exercises</li> <li>▶ Coaching methodology</li> <li>▶ Psycho-education</li> </ul>

Continued



Table 2 Continued

Items	Domains	Strategies
8	Motivational strategies	<ul style="list-style-type: none"> <li>▶ Patient's videos to show improvement</li> <li>▶ mHealth (any form of monitoring, consultation, assessment, or therapy delivered using mobile devices)</li> <li>▶ Interim assessments</li> <li>▶ Feedback on progress—importance to micro gains</li> <li>▶ Positive log diary</li> <li>▶ Wall of fame/display board</li> <li>▶ Provide tokens and badges for improvement</li> <li>▶ Methods of education and counselling</li> <li>▶ Devise colour bands (coded for level of recovery)</li> <li>▶ Intra-group competition</li> <li>▶ Avoid direct comparison</li> </ul>
9	Reminder strategies	<ul style="list-style-type: none"> <li>▶ Reminder phone calls</li> <li>▶ Use of media</li> <li>▶ Sticky notes</li> <li>▶ Alarms/music clips</li> <li>▶ Auditory—use voice recording during therapy sessions</li> <li>▶ Logbook</li> <li>▶ Posters in the waiting area for hospital settings</li> <li>▶ WhatsApp (or similar) for reminder</li> </ul>

such as work/politics/current affairs/sports.) Some strategies for involving society include having weekly phone/face-to-face interactions with colleagues, family, and friends, or joining/creating support groups or associations of families with stroke. Testimonials of recovered patients and their experiences with rehabilitation can be used for motivating other patients. Additional ways to include community are awareness programmes for healthy adults, local group exercise for people with stroke and peer support or exercise buddies.

#### Domain VII: promoting self-efficacy

Experts suggested using evidence-based behaviour change strategies (e.g., the Capacity Opportunity Motivation-Behaviour model,<sup>36</sup> or Intervention Mapping approach<sup>25</sup> and using rehabilitation principles of substitution and optimisation. Some suggested strategies to promote self-efficacy include:

- ▶ Collaborating with patients to devise the best monitoring strategy for them such as exercise practice sheets, paper, electronic diary or internet-based applications.
- ▶ Providing continual support after the termination of the formal therapy programme.
- ▶ Providing personal graph charts of success that can be generated weekly or monthly.
- ▶ Ensuring an adequate number of activities in which the patient can engage independently or with minimal supervision.
- ▶ Identifying anchors in the day (sleep times/meals/activities—exercise, recreation, social) and setting a general intention of sticking to their exercise programme or developing contingency 'if/then' plans.
- ▶ Discuss and explore potential barriers that would impede or hinder exercise sessions with patients.

- ▶ Overcome barriers using pie charts, pros versus cons analysis/identification of cognitive distortions/downward arrow techniques/developing a life brochure/movement or art-based therapeutic activities.
- ▶ Motivation interviewing to help to elicit patients' intention to adhere to exercises and understand their motivation level.

#### Domain VIII: motivational strategies

Panel experts suggested that motivation can be facilitated by establishing positive feedback mechanisms at home with caregivers' help to reward adherence. Motivational strategies can be implemented as follows:

- ▶ Showing functional improvements or devising individual graphs (every three sessions plus monthly).
- ▶ Having a display board/wall of fame where 'patient of the month' and photos of patients achieving good outcomes could be displayed in a rehabilitation centre or common mHealth application.
- ▶ Using productivity monitoring tools to keep them motivated.
- ▶ Maintaining a daily log for positive feelings or gratitude journal, and telephone follow-up where the medical team provides words of encouragement can promote adherence.
- ▶ Having video feedback at regular intervals, setting progressive but attainable targets, and involving patients in goal setting may motivate patients to continue exercising.
- ▶ Devising wrist bands of different colours (coded for level of recovery and mastery of tasks).
- ▶ Giving t-shirts or wrist bands of that colour and upgrading as they progress to encourage regular exercising.
- ▶ Competitions during group sessions among people with similar impairments and provide tokens or badges

for improvement that can be exchanged for tangible rewards to make exercising fun and interesting.

- ▶ Having an interactive internet-based community where people can add friends to motivate each other to exercise can also be a solution in times of social distancing.

#### Domain IX: reminder strategies

Experts agreed on reminder strategies including:

- ▶ Calling patients regularly and visiting them weekly or fortnightly.
- ▶ Using sticky notes in the patients' homes, tally sheets, pamphlets or text messages/WhatsApp reminders.
- ▶ Therapists can show exercise videos so that patients can accurately remember each exercise step and use the same video for home practice.
- ▶ Use of technology such as sending small feedback surveys, disease information, scientific literature, and progress cards to keep the patients engaged and motivated to continue exercises.
- ▶ Using daily logs (electronic or paper-and-pencil) and weekly reviewing of the exercise log to help stick to a schedule.

## DISCUSSION

We aimed to develop a comprehensive set of clinically applicable strategies for optimising adherence to home-based exercises after a stroke. In a Delphi method, experts from different fields co-construct knowledge and provide recommendations on a particular topic.<sup>37</sup> In our study, we incorporated knowledge from experts in exercise science, behaviour science and experts experienced in community care to develop the set of strategies.

The 10-item open-ended survey, used in the first round, was based on our qualitative study<sup>15</sup> that explored factors influencing adherence among stroke survivors using the Intervention Mapping approach,<sup>38</sup> which is underpinned by the Socio-Ecological Model.<sup>39</sup> Our framework is constructed on the Socio-Ecological Model of behavioural change. Since there is limited access to healthcare facilities, higher cost of clinic-based rehabilitation, and lack of transport to hospital setup in low resource settings, home-based exercise adherence becomes crucial for recovery. The developed adherence strategies could be influential for the success of home-based rehabilitation in the long term.

The suggested strategies were categorised into nine domains, which were in line with the findings in existing systematic reviews.<sup>21 40 41</sup> The included studies reported behaviour strategies and theories such as self-efficacy,<sup>21</sup> motivational interventions,<sup>40</sup> social-cognitive theory,<sup>32</sup> activity-monitoring, feedback system, goal-setting,<sup>41</sup> self-regulated exercises,<sup>42</sup> for improving adherence. However, none of the studies had used Delphi approaches and provided broad concepts for enhancing exercise adherence without providing specific context, culture or techniques for delivering the interventions.

Adherence is affected by multiple factors such as age, self-efficacy, caregiver support, previous exercise behaviour, the severity of stroke and stages of stroke recovery.<sup>18-20 43 44</sup> Therefore, the framework of strategies provides the opportunity to individualise the strategies based on each person's impairments, recovery, the severity of stroke and available support system. The exercises can be tailored depending on the abilities and context of each person.

Adherence to poststroke rehabilitation is a dynamic process and changes with each stage of recovery, characterised by a higher adherence rate during the initial period of recovery, followed by a slow decrease in adherence rate and a stable phase where adherence does not change much.<sup>45</sup> Some strategies such as enhancing self-efficacy, activity scheduling, regular feedback and monitoring can be initiated during the early phase while strategies such as interim progress tracking, personal graphs, involvement of peer group, gamification of exercises, providing rewards, and reminders can be started gradually to break the monotony of ongoing exercise programmes and encourage adherence. Therefore, implementing these adherence strategies early in rehabilitation can be beneficial for maintaining adherent behaviour in the long term. The results from a meta-analysis of mixed disease populations demonstrated that adherence is low when perceived disease severity is high among patients with serious illnesses.<sup>46</sup> However, future studies are needed to establish the effects of stroke severity on exercise adherence.

The different sets of strategies within the framework can be deployed to improve exercise adherence after stroke. The framework is useful for stroke survivors, caregivers and healthcare providers as it offers adherence techniques at a personal, interpersonal and organisational level. It gives clear recommendations on each strategy's content, different ways of delivering it, healthcare professionals who should design it, and one who might benefit from those strategies.

The strategies that were agreed on by more than 60% of experts were included while the remaining uncertain strategies were excluded. The excluded strategies were participating in social events, regular checks by neighbours or games/competition with family/caregivers. Such strategies may improve the social interaction but may not be feasible due to the caregiver's burden after stroke,<sup>47</sup> and family members may not find adequate time for such activities. Other uncertain strategies such as virtual reality, circuit training or award function were excluded due to the cost, training and equipment required.<sup>15</sup> Strategies such as educating patients on the location and types of stroke and educational movies were considered redundant for improving exercise adherence.<sup>48</sup> Although social media such as Whatsapp was agreed on by the experts as a mode of reminder, Whatsapp groups were not preferred as a strategy due to fear of dissemination of inaccurate information among the participants and compromising the privacy of health information.

The key strength of this study lies in the multidisciplinary nature of the expert panel that was recruited, which included specialists in exercise prescription, experts in behaviour and community experts having diverse experiences that contributed to developing a multi-faceted framework of strategies. Due to the pandemic that has compromised clinic-based rehabilitation worldwide, these strategies can be delivered in any healthcare setting, are easy to implement, affordable and offer a comprehensive set of strategies to facilitate exercise adherence. We have tested the framework of strategies in a recent randomised controlled trial and found it to be effective in improving adherence levels among people with stroke.<sup>26</sup> Choosing the strategies from the framework can help in the pragmatic implementation in clinical practice or research trials. The framework is a useful guide for both clinicians and researchers to select appropriate strategies for enhancing exercise adherence.

We did not include stroke survivors and caregivers in the Delphi panel which we consider a limitation of this study. However, the perceptions of stroke survivors were explored to develop the questionnaire for the first round.<sup>15</sup> The representation of experts from each speciality was unequal which could have influenced the decision-making process that differentiated certain vs uncertain strategies. Hence, some of the strategies deemed uncertain may have clinical relevance for supporting adherence. Moreover, as the open-ended questionnaire was developed from the literature review and opinions of stroke survivors in the previous study, the experts did not get a chance to develop the initial themes.

## CONCLUSION

A set of strategies and a framework for enhancing adherence to home-based exercises after stroke has been developed and classified under nine domains: patient education on stroke and recovery, exercise prescription, feedback and supervision, cognitive remediation, the involvement of family members, the involvement of society, promoting self-efficacy, motivational strategies and reminder strategies. In countries where home-based exercises are the mainstay of rehabilitation, these strategies could reinforce self-management and facilitate adherence in the long term. Future studies should explore the experiences of stakeholders in implementing these strategies using qualitative methods. The set of strategies could be incorporated in a telerehabilitation model and cost analysis could be performed in the future.

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**Acknowledgements** We are grateful to Dr. Margaret Galloway, University of Newcastle, Australia for her timely inputs in the language of manuscript. We thank Mr. Amit Manohar Sinha, LIC, India and Dr. Pradeepa Nayak, Manipal Academy of Higher Education, for their assistance and support during the study.

**Contributors** The idea was conceptualised by JMS and MN. AM, JMS and MN developed the protocol. AM contacted the experts and prepared the 10-item questionnaire. ADe, DM, GV, SP, STS, ADi, SK, GN, HS, SKV, SK, BU and CE formed the expert panel and contributed in the development of the framework. AM analysed the data and prepared the first draft. All authors have contributed in drafting and revising the manuscript. JMS is the guarantor of this article.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient consent for publication** Not applicable.

**Ethics approval** This study was approved by Institutional Ethics Committee, Kasturba Hospital, Manipal, India approved this study (IEC:355/2017).

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** All data relevant to the study are included in the article or uploaded as online supplemental information.

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# Supplementary file 1: Open-ended questionnaire and summary of responses obtained in Round 1

<p><i>Q1. Please list the contents that should be included in the patient education about stroke recovery. Suggest a few approaches that could be used for education?</i></p> <p>Answers: Educating about stroke, its usual course of recovery, do's and don'ts, benefits of exercises, complications of stroke and its management, and role of caregiver.</p>
<p><i>Q2. Please suggest ways for exercise prescription?</i></p> <p>Answers: Prescription of exercises in the form of videos, written instructions, pictures along with demonstration and practice. Prescribing few individualized exercises which are fun and engaging.</p>
<p><i>Q3. Please suggest ways for taking regular feedback from a patient and clearing any doubts during exercises?</i></p> <p>Answers: Regular contact with therapists, use of apps or mHealth, monitoring exercises, daily log, and charting of activities.</p>
<p><i>Q4. Please suggest a way of cognitive remediation for facilitating adherence?</i></p> <p>Answers: Use of Cognitive Behavior Therapy techniques, motivational interviewing, and counselling. Positive reinforcement and importance to micro gains.</p>
<p><i>Q5. Please suggest on how family members can help to facilitate adherence?</i></p> <p>Answers: Emotional support, encouragement, being exercise buddies, setting up reminders, and preventing complications.</p>
<p><i>Q6. Please suggest ways on how friends, neighbor, colleagues, others can be involved to encourage exercise?</i></p> <p>Answers: Frequent interaction with friends and colleagues, group therapy, association of families, comparison with others.</p>
<p><i>Q7. Please suggest ways to train the patients to self-monitor &amp; continue exercising and solve problems related to exercise adherence?</i></p> <p>Answers: Monitoring exercises, personal graphs, activity scheduling, promoting self-efficacy, and problem-solving, provide ongoing support.</p>
<p><i>Q8. Please provide ways for motivating patients to adhere to interventions?</i></p> <p>Answers: Showing improvement and progress, standard and interim assessments, positive feedback mechanisms, telephonic follow up, positive log, and track of consultations.</p>
<p><i>Q9. Please suggest ways for providing reminders to exercises?</i></p> <p>Answers: Regular follow up, tally sheets, reminders, apps, daily logs, pamphlets, cues and prompts.</p>
<p><i>Q10. Please suggest features of a web-app/mhealth intervention to facilitate adherence?</i></p>



Answers: Tracking and real-time feedback, activity mapping, virtual games, daily reminders, personalized information, interactive community, progress report, and appreciation.

## Supplementary file 2: Level of agreement between experts on uncertain strategies in Round 2

S. No	Unsure strategies	Agreeing experts, n (%) (N=11)	Strategy included for the next round
1.	Activity log/scheduling	8 (73)	Included
2.	Award function every two months	3 (27)	Excluded
3.	Certain use of aids may help them for better balance and self-efficacy	4 (36)	Excluded
4.	Circuit training	1 (9)	Excluded
5.	Coaching methodology	7 (64)	Included
6.	Competition for caregivers and family	2 (18)	Excluded
7.	Contingency charts /plan	9 (82)	Included
8.	Devise color bands coded for level of recovery and mastery of tasks	7 (64)	Included
9.	Information on stroke type and location	4 (36)	Excluded
10.	Home movies for family viewing	4 (36)	Excluded
11.	Individualized program	9 (82)	Included
12.	Involving group sessions	7 (64)	Included
13.	mHealth	7 (64)	Included
14.	Participation in social events	4 (36)	Excluded
15.	Peer support/exercise buddies	8 (73)	Included
16.	Pie chart for social and emotional impact on the patients	3 (27)	Excluded
17.	Posters in the waiting area	7 (64)	Included
18.	Provide tokens and badges for improvement	8 (73)	Included
19.	Psychoeducation	9 (82)	Included
20.	Regular check by neighbors	1 (9)	Excluded
21.	Rotate family members in caregiving	8 (73)	Included
22.	Task-oriented therapy	8 (73)	Included
23.	Virtual reality	4 (36)	Excluded
24.	Wall of fame/display board	7 (64)	Included
25.	Whatsapp group	4 (36)	Excluded

### Supplementary file 3: Framework of strategies for facilitating home-based exercise adherence post stroke

S.no	Domain	Strategies	Healthcare provider	Stakeholder
1	Education about stroke and recovery	<ul style="list-style-type: none"> <li>• Education on usual time course and speed of recovery after stroke</li> <li>• Impact of practice and exercise on recovery</li> <li>• Negative effects of rest and positive effects of activity on stroke recovery</li> <li>• Importance of secondary risks management</li> <li>• Managing complications (e.g., spasticity, pain, fatigue, contracture, depression and cognitive changes)</li> <li>• Awareness on interventions without evidence (including traditional medicines and religious practices)</li> <li>• Importance of adhering to the exercise program</li> <li>• Dosage of the exercise program</li> <li>• Information about expected outcomes based on severity</li> <li>• Proper positioning techniques</li> <li>• Misconceptions about stroke recovery</li> <li>• Role of a caregiver</li> </ul> <p>Education can be delivered via written information, group sessions, individual discussions, testimonials from recovered patients and caregivers, phone calls</p>	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse) Licensed psychologist trained in health behavior	Patient, Caregiver
	Domain	Strategies	Healthcare provider	Stakeholder

<b>2</b>	<b>Exercise prescription</b>	<ul style="list-style-type: none"> <li>• Relevant exercises for each persons' goals and context</li> <li>• Individually-tailored exercises</li> <li>• Contingency plan and including enough opportunities for independent and autonomous activities</li> <li>• Personalized information/messages on the exercise prescription</li> <li>• Fun and engaging such as gaming or gamification</li> <li>• Use of voice-assisted programs or web-app</li> <li>• Prioritizing and focusing on only a few activities at a time</li> <li>• Demonstration and practice of the prescribed exercises</li> <li>• Written and pictorial instructions (avoid using too many colors and keep it simple and clean)</li> <li>• Videos of exercises</li> <li>• Simple written handout - no more than one printed page</li> <li>• Using a minimum of two and maximum of three mediums (various sensory modalities) when prescribing information</li> <li>• Online tracking application (feed-in everyday progress)</li> <li>• Video recording of patients' exercise performance</li> <li>• Splitting the exercise into smaller and easier steps, and gradually increasing in difficulty</li> </ul>	<p>Exercise therapist (Physiotherapist, Occupational therapists, Psychiatrist, Stroke nurse)</p> <p>Licensed psychologist trained in health behavior</p>	Patient
	<b>Domain</b>	<b>Strategies</b>	<b>Healthcare provider</b>	<b>Stakeholder</b>

3	<b>Feedback and supervision</b>	<ul style="list-style-type: none"> <li>• Maintaining an exercise log</li> <li>• Daily monitoring of health status and updates of patients by the medical team</li> <li>• Exercise charts - with pictures of each step and a simple breakdown of the activities</li> <li>• Clearing doubts</li> <li>• Obtaining information on progress from patients and caregivers and their experience/quality of care/interaction</li> <li>• Evaluate frequency, form, intensity, and duration of exercise</li> <li>• Maintaining some form of regular contact with therapists - in person or via telehealth</li> <li>• Online web applications that can be accessed by the patients, caregivers, and medical team for recording everyday health status</li> <li>• Recorded audio/video clips to guide the exercise session</li> <li>• Individual and group discussion</li> <li>• Internal feedback</li> <li>• Providing verbal/manual cues at salient points during the exercise, and asking the person what went right and what could be improved</li> <li>• Standardized assessment using clinical outcome measures</li> </ul>	<p>Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)</p> <p>Licensed psychologist trained in health behavior</p>	Patient
	<b>Domain</b>	<b>Strategies</b>	<b>Healthcare provider</b>	<b>Stakeholder</b>
4	<b>Cognitive remediation</b>	<ul style="list-style-type: none"> <li>• Prescribing functional tasks and planning the exercises focusing on patients' goals</li> <li>• Understanding the exercise behavior of the patient before the treatment session</li> <li>• Educating the patients and caregivers about the benefits of performing exercises</li> <li>• Incorporating a schedule, involving group sessions, and relevant tasks</li> <li>• Positive feedback, reinforcement, and giving importance to micro gains</li> <li>• Assessing intention to exercises-use of Motivation Enhancement Therapy or motivational interviewing</li> <li>• Contingency charts and behavioral activation</li> </ul>	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)</p>	Patient, caregiver



	Domain	Strategies	Healthcare provider	Stakeholder
5	Involvement of the family members	<ul style="list-style-type: none"> <li>The family must be involved for a limited amount since it encourages dependency</li> <li>Management of expressed emotions of the family members that may hinder treatment and restrict the autonomy of the patient</li> <li>Evaluating caregivers' burden and having frequent sessions to reduce the burnout and to encourage their efforts towards the patient</li> <li>Assessing knowledge and understanding of the caregivers on the importance of post-stroke exercises</li> <li>Family can provide emotional support and encouragement</li> <li>Exercise buddies</li> <li>Setting up reminders on the patients' phone for anchor points of the day (daily routines/meals/exercise/leisure activities/family time/planned activities)</li> <li>Developing, demonstrating, and practicing activities with family</li> <li>Reinforcing adaptive behaviors</li> <li>Assisting in exercises and preventing complications</li> <li>Designing a few exercises that involve family members</li> <li>Rotation of family members for caregiving roles (reduces burnout, improves support, and maintains novelty)</li> <li>Tracking the progress and delivering rewards to the patient - tangible/intangible</li> </ul>	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)</p>	Caregiver
	Domain	Strategies	Healthcare provider	Stakeholder
6	Involvement of society	<ul style="list-style-type: none"> <li>Interaction with colleagues on topics not concerning the illness (preferably the patient's work/politics/current affairs/sports)</li> <li>Weekly scheduled interactions (phone/face-to-face) with friends, neighbors or colleagues</li> <li>Creating an association of families caring for stroke or support group</li> </ul>	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke</p>	Community

		<ul style="list-style-type: none"> <li>• Testimonials of recovered patients and their experiences about rehabilitation</li> <li>• Awareness programs for healthy adults</li> <li>• Group exercise for stroke survivors in that particular locality</li> <li>• Peer support or exercise buddies</li> </ul>	nurse)	
	<b>Domain</b>	<b>Strategies</b>	<b>Healthcare provider</b>	<b>Stakeholder</b>
7	<b>Promoting self-efficacy</b>	<ul style="list-style-type: none"> <li>• Use of evidence-based behavior change strategies (e.g., the Capacity Opportunity Motivation-Behavior model, or Intervention Mapping or Coaching Methodology)</li> <li>• Using substitution and optimization principles</li> <li>• Working out with patients on what monitoring will be best for them - exercise practice sheet, paper diary, electronic diary, app</li> <li>• Providing ongoing support once the therapy program has ended</li> <li>• Personal graph chart of success that can be generated weekly or monthly</li> <li>• Ensuring an adequate number of activities in which the patient can engage independently or with minimal supervision and support from the caregivers</li> <li>• Setting reminders on the phone or alarms on the clock; identifying anchors in the day (sleep times/meals/activities - exercise, recreation, social)</li> <li>• Setting a general intention of sticking to their exercise program with more specific goals (i.e., intention and "if/then" plans)</li> <li>• Patients could be advised to think of barriers that would impede their exercise sessions, and list ways of overcoming such barriers</li> <li>• Use of pie-charts/pros-con analysis/identification of cognitive distortions/downward arrow techniques for problem analysis and developing a life brochure and art-based therapeutic activities for promoting self-efficacy</li> </ul>	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)</p>	Patient

	Domain	Strategies	Healthcare provider	Stakeholder
8	Motivational strategies	<ul style="list-style-type: none"> <li>Tracking and reporting exercise adherence</li> <li>Showing functional improvement</li> <li>Measuring performance-repetitions, duration of exercise, exercise intensity, or distance walked</li> <li>Positive feedback mechanisms at home with the help of caregivers to reward adherence and home activities</li> <li>Importance to micro gains</li> <li>Reminding positive experiences with exercise before a stroke</li> <li>Measuring functional improvements using clinical measures that can help patients appreciate improvements in their health</li> <li>Telehealth, self-monitoring, diaries</li> <li>Devise individual graphs (every three sessions plus monthly)</li> <li>Have a display board/wall of fame where "patient of the month" and photos of patients achieving good outcomes is displayed online or in clinical setup</li> <li>Telephonic follow-up where the medical team provides words of encouragement</li> <li>Productivity monitor that has to be filled out by the patient to code the level of functioning for every day in various domains</li> <li>Maintaining a positive log (paper-pencil or online) two events each day gave the patient a reason to be happy</li> <li>Feedback at regular intervals using objective outcomes</li> <li>Setting progressive but achievable targets and involving patients in goal setting</li> <li>Devising color bands (coded for level of recovery and mastery of tasks). Reinforcing the patients by providing t-shirts or color bands of a particular color that represents certain level of recovery or mastery of task. Upgradation of color bands with progression of tasks.</li> </ul>	<p>Licensed psychologist trained in health behavior</p> <p>Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)</p>	Patient

		<ul style="list-style-type: none"> <li>• Conducting intra-group competitions for patients (within a given color band) during group sessions</li> <li>• Providing tokens and badges for improvement - which can be exchanged for tangible rewards</li> <li>• Interactive community - can add friends to motivate each other using web app or in community centers</li> </ul>		
	<b>Domain</b>	<b>Strategies</b>	<b>Healthcare provider</b>	<b>Stakeholder</b>
<b>9</b>	<b>Reminder strategies</b>	<ul style="list-style-type: none"> <li>• Calling them on a regular basis and visiting them weekly or fortnightly</li> <li>• Tally sheet, mobile applications, pamphlets, SMS reminders or WhatsApp reminders</li> <li>• Using videos to show exercise steps and giving the same material for home practice</li> <li>• Auditory - use voice recording during the exercise session so that the patient can use the same tapes at home during practice</li> <li>• Alarms/music clips to indicate the time to switch between exercises</li> <li>• Technology - sending small surveys about feedback, information, some scientific literature, and progress card</li> <li>• Daily logs - either electronic or paper-pencil to track mood, exercise, food intake, sleep, social engagement, and grooming activities</li> <li>• Audio – alarms to orient patient to engage in tasks and taking medications.</li> <li>• Weekly reviewing the exercise log</li> <li>• Cues/prompts such as sticky notes in the patients' homes</li> <li>• Follow-up phone calls from the health care professionals</li> <li>• Visible wall posters on exercises</li> </ul>	Exercise therapist (Physiotherapist, Occupational therapists, Physiatrist, Stroke nurse)	Patient, caregiver