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Research

Two weeks of intensive sit-to-stand training in addition to usual care improves sit-to-stand ability in people who are unable to stand up independently after stroke: a randomised trial

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KEY WORDS

Stroke
Sit-to-stand
Repetitive training
Physical therapy
Randomised trial

ABSTRACT

Question: Does intensive sit-to-stand training in addition to usual care improve sit-to-stand ability in people who are unable to stand up independently after stroke? **Design**: A multi-centre randomised controlled trial with concealed allocation, assessor blinding and intention-to-treat analysis. **Participants**: Thirty patients from two Sydney hospitals, < 3 months after stroke, with a mean Modified Rankin Scale score of 4 points (SD 0.5). **Intervention**: All participants received usual care. Participants in the experimental group attended two additional sessions of physiotherapy per day for 2 weeks. These sessions were individualised to the needs of each participant in order to increase the amount and intensity of sit-to-stand training. **Outcome measures**: Outcome measures were taken at baseline and at 2 weeks. The primary outcome was clinicians' impressions of sit-to-stand change, measured using videos and a 15-point Global Impressions of Change Scale. Secondary outcomes were sit-to-stand ability, composite strength of key muscles of the affected lower limb, gross lower limb extension strength, the Goal Attainment Scale, and ranking of change in ability to move from sitting to standing. **Results**: All participants completed the trial. The mean between-group difference for clinicians' impressions of sit-to-stand change was 1.57/15 points (95% CI 0.02 to 3.11). The secondary outcomes that indicated a treatment effect were gross lower limb extension strength and ranking of change in ability to move from sitting to standing, with mean between-group differences of 6.2 deg (95% CI 0.5 to 11.8) and −7 (95% CI −1 to −13), respectively. **Conclusion**: Two weeks of intensive sit-to-stand training in addition to usual care improves sit-to-stand ability in people who are unable to stand up independently after stroke. **Trial registration**: ANZCTR 12616001288415. **[de Sousa DG, Harvey LA, Dorsch S, Varettas B, Jamieson S, Murphy A, Giaccari S (2019) Two weeks of intensive sit-to-stand training in addition to usual care improves sit-to-stand ability in people who are unable to stand up independently after stroke: a randomised trial. *Journal of Physiotherapy* 65:152–158]**
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Introduction

After stroke, many people have difficulty standing up and walking independently, due to motor impairments such as weakness and poor co-ordination. Loss of the ability to stand up can result in profound disability[1] and increased burden of care.[2] There is strong evidence that repetitive training of sitting,[3] standing up,[4] standing,[5] and walking[5] after stroke improves these functional tasks. There is also evidence that large amounts (more than triple the usual amount) of additional training improves functional outcomes after stroke.[6] However, it cannot be assumed that the effects of additional training are the same for all tasks because individual tasks may require different amounts of training. For example, tasks involving the upper limb appear to require more training than tasks involving the lower limb.[7]

Since standing up independently is essential for reducing disability and burden of care, it is important to understand if additional repetitive sit-to-stand training improves the ability to stand up independently after stroke. Five clinical trials have investigated the effects of additional repetitive sit-to-stand training after stroke.[8–12] Three of the five trials are not relevant for people who are very disabled and unable to stand up independently because these trials only recruited people who could stand up without assistance.[9,10,12] Another trial recruited a mix of people who could and could not stand up independently, and only provided a very imprecise estimate of the treatment effect.[11] The only remaining relevant trial, which specifically recruited people who could not stand up independently, had methodological issues affecting the validity of the results and did not provide intensive sit-to-stand training to participants.[8] Overall, these five trials do not provide clear evidence

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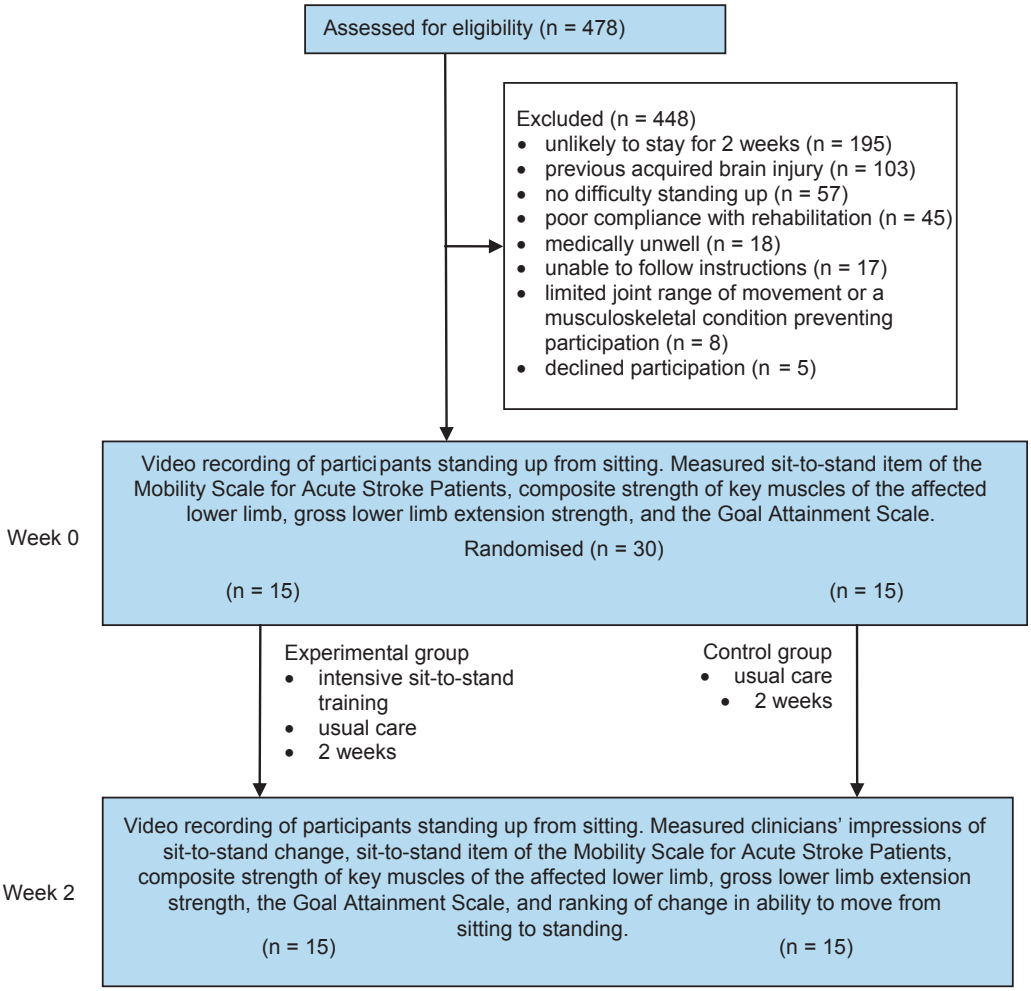

Figure 1. Design and flow of participants through the trial.

of the effectiveness of additional repetitive sit-to-stand training in people who are unable to stand up independently after stroke.

The primary aim of this trial was to determine if intensive sit-to-stand training in addition to usual care improves sit-to-stand ability in people who are unable to stand up independently after stroke.

Therefore, the research question for this multi-centre randomised controlled trial was:

> Does intensive sit-to-stand training in addition to usual care improve sit-to-stand ability in people who are unable to stand up independently after stroke?

Methods

Design

An assessor-blinded randomised controlled trial was undertaken (Figure 1). A person not involved in the trial created a blocked random allocation schedule for 30 participants using Microsoft Excel. The blocking ensured equal numbers of participants in the experimental and control groups. Participants' allocations were placed in opaque, sequentially numbered and sealed envelopes that were held offsite by a person not involved in the trial. Once participants passed the screening process and completed the initial assessment, trial staff contacted the independent person who opened an envelope and revealed the group allocation. Participants were considered to have entered the trial at this point. Participants were re-assessed at the end of the 2-week intervention period. All applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed.

Participants

All patients admitted to two hospitals between 21 June 2016 and 16 October 2018 were screened for inclusion. The inclusion criteria were as follows: first-time stroke or any other non-progressive acquired brain injury; < 6 months after stroke or brain injury; difficulty standing up due to the effects of stroke or brain injury; and sufficient communication skills to indicate yes/no verbally or via gestures. Patients were excluded for any of the following reasons: limited passive joint range of movement or musculoskeletal conditions that would prevent participation; inability to participate in exercise (ie, medically unwell or unable to tolerate usual physiotherapy); and expected length of stay < 2 weeks.

Experimental group

Participants allocated to the experimental group participated in two additional sessions of physiotherapy per day for 2 weeks in addition to usual care. Each additional session was at least 30 minutes during the week (hence, an additional 1 hour per day) and 1 hour on the weekend (2 hours per day). However, the sessions were sometimes longer than this if tolerated by the participants. The sessions were individualised to the needs of each participant in order to increase the amount and intensity of sit-to-stand training (see Box 1). All sit-to-stand training was based on the principles of task-specific motor training, with an emphasis on repetition, and the use of visual targets to provide an external focus to the movement. Training also incorporated verbal feedback. Intensity of training was increased by increasing the number of repetitions performed in a specified time. Training was also steadily progressed by lowering the

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Box 1. Protocol and progression of sit-to-stand training.

Participants who could perform the whole sit-to-stand task from raised treatment beds with supervision were set up with a wall on their unaffected side and chairs or tables around them so they could practise moving from sitting to standing repetitively and safely.

If participants were unable to perform the whole sit-to-stand task, they performed part-practice of components of the sit-to-stand task until they were able to move from sitting to standing with assistance. For example, if participants could not move from sitting to standing due to weakness and poor co-ordination of their affected lower limb extensors, they performed many repetitions of squats on a sliding tilt-table.

If participants could not move from sitting to standing due to weakness and poor co-ordination of their affected lower limb hip flexors and extensors, they performed many repetitions of reaching beyond their arms' length for targets whilst loading their affected lower limb.

Participants were encouraged to achieve a daily target of sit-to-stand repetitions. If they could not reach this target, they were encouraged to perform as many repetitions of the sit-to-stand task per day as they could tolerate.

Participants were provided with visual targets (ie, tape on a wall to provide a visual target for shoulder alignment, or tape on a chair corresponding with tape on the knee of their affected lower limb to provide a target for knee alignment prior to moving from sitting to standing).

Verbal feedback about the quality of participants' movements were also provided.

Intensity of training was increased by increasing the amount of repetitions performed in a specified time.

Progression of sit-to-stand training followed these general principles:
Training was made progressively more difficult to continue to challenge each participant's motor ability.

If participants could achieve more than 50 repetitions in $<$ 15 minutes, the exercise was made more difficult.

If participants were unable to achieve 25 repetitions within 15 minutes, the exercise was made easier.

The new version of the exercise was adopted until more than 100 repetitions were achieved following the method above.

If participants could not perform a previously tolerated exercise on a specific day for any reason (ie, they were medically unwell) but were stable enough to participate in therapy, the task was made easier so that the day's repetition target could be achieved.

Training was also steadily progressed by lowering the height of treatment beds, altering foot position to increase weight-bearing through the affected lower limb, and standing up with a foam mat under the feet. All these strategies were used to ensure that each participant trained at his/her maximal capacity.

height of treatment beds, altering foot position to increase weight-bearing through the affected lower limb, and standing up with a foam mat under the feet. All these strategies were used to ensure that each participant trained at his/her maximal capacity. Additional strategies were used to facilitate extra sit-to-stand training during therapy hours and after hours (Table 1). Both the experimental and control groups received usual care, namely two 1-hour sessions of physiotherapy each weekday.

One therapist with over 10 years of experience in neurological physiotherapy was responsible for treating all experimental participants and did not treat any of the control participants. Attempts were made to keep the therapists responsible for treating the control participants naïve to the purpose of the trial. That is: they were not told the purpose of the trial or the details of the intervention. Similarly, all participants were kept naïve to the purpose of the trial. For example, the participant information sheets and consent forms did not disclose the specific experimental intervention, and experimental participants were not told that they were specifically focusing on sit-to-stand.

Control group

Participants allocated to the control group received usual care only. A detailed description of usual care is presented in the next section.

Table 1
Strategies individualised to the needs of each participant to increase the amount of sit-to-stand training.

Strategies	Exp	Con
Physiotherapy gym $\geq$ 3 hours/weekday	Provided	Not provided
Semi-supervised practice	Provided	Ad hoc
Therapy on weekend days	Provided	Not provided
Exercise diary	Provided	Not provided
Structured training for carers/family	Provided	Ad hoc and unstructured
Individualised after-hours exercise program	Provided	Ad hoc

Con = control group, Exp = experimental group.

Usual care

Usual care consisted of two 1-hour sessions of physiotherapy each weekday. This therapy involved strength, endurance, balance and co-ordination exercises as well as task-specific training of sitting, sit-to-stand, standing, and walking. Exercise repetitions for both groups were counted using a hand-held counter. The time that participants participated in therapy was recorded. The two hospitals were similar and participants received multi-disciplinary care from occupational therapists, speech pathologists and nurses.

Outcome measures

All participants were assessed by a blinded assessor before randomisation and at the end of the 2-week intervention period. Participants were asked not to discuss their training or group allocation with the assessors. The success of blinding was verified at the end of each participant's assessment by asking assessors to reveal whether they had become un-blinded. All assessors received training prior to commencement of the trial and were given assessment protocols to improve inter-rater reliability. Where possible, the same assessor was used to perform the initial and final assessments. Additional demographic data to describe the sample were collected prior to randomisation. This included Modified Rankin Scale scores, age, gender, time since injury, type of acquired brain injury, and affected side.

The primary outcome was clinicians' impressions of sit-to-stand change. The secondary outcomes were sit-to-stand ability using the sit-to-stand item of the Mobility Scale for Acute Stroke Patients, composite strength of key muscles of the affected lower limb, gross lower limb extension strength, the Goal Attainment Scale, and ranking of change in ability to move from sitting to standing.

Clinicians' impressions of sit-to-stand change

Change in sit-to-stand ability was assessed using a 15-point Global Impressions of Change Scale.[13] This involved taking short video recordings of participants attempting or performing an independent sit-to-stand at baseline and again at 2 weeks. Each video was

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between 2 and 5 minutes in duration and the angle of the camera and distance between the camera and participant were standardised. Participants were permitted to wear shoes but lower limb aids and orthoses were removed and standardised for both assessments. Participants were positioned in the middle of a treatment bed set at a height of 60 cm, with their ankles in dorsiflexion and their heels on the ground. Participants were asked to stand up with their arms crossed over their chests. If participants could not stand up independently, they were permitted to place their arm/s on their thigh/s to assist. If participants still could not stand up independently, they were permitted to push through their hands on the bed to assist with standing up. If participants still could not stand up independently, assistance was provided by a physiotherapist not involved in the trial and blinded to group allocation. If necessary, a second person provided assistance for participants to stand up. If participants could stand up independently from 60 cm, the bed height was incrementally lowered by 5 cm, and then a further 5 cm after every successful attempt at standing up. The assessment ceased when participants could no longer stand up independently, or could not stand up safely with maximal assistance of two people. If participants were initially unable to stand up with assistance of two people from a height of 60 cm, they were challenged to reach beyond their arms' length to the limits of their abilities whilst seated.

All videos were collated into pairs corresponding with the initial and final assessment of each participant. Thirty pairs of videos were generated (60 videos in total) and viewed on two separate adjoining screens. The video taken at the time of a participant's initial assessment always appeared on the left screen and the final assessment on the right. Two blinded assessors (one with $>$ 20 years and one with 4 years neurological physiotherapy experience) were asked to separately view the pairs of videos and rate the change in the ability of participants to move from sitting to standing independently, using a Global Impressions of Change Scale. Assessors were asked to take into consideration the severity of participants' disabilities and the amount of change expected over a 2-week period. The Global Impressions of Change Scale is a 15-point scale with -7 representing 'very much worse', 0 representing 'no difference', and $+7$ representing 'very much better'. A mean between-group difference of 2/15 points was considered clinically important for this outcome prior to the commencement of the trial.

Sit-to-stand ability

Sit-to-stand ability was also assessed using the sit-to-stand item of the Mobility Scale for Acute Stroke Patients.[14] This item is rated on a 6-point scale based on level of assistance required to move from sitting to standing. A score of 1 denotes inability to move from sitting to standing and a score of 6 denotes the ability to move from sitting to standing unassisted, safely, and with no verbal input.

Composite strength of key muscles of the affected lower limb

The strength of the hip extensors, knee extensors, and plantar flexors of the affected lower limb were assessed using the Manual Muscle Test, consisting of 6 grades (ie, 0 = no muscle contraction to 5 = moves joint through full available range and holds against maximal resistance).[15] Scores for the three muscle groups were combined and treated as a composite measure of lower limb extensor strength, with 15 points representing the maximum score.

Gross lower limb extension strength

Gross lower limb extension strength of the affected lower limb was assessed using an inclinometer on a sliding tilt table. Each participant was transferred to a sliding tilt table. The participant was positioned with the affected lower limb on the foot plate and the knee in 70 deg of flexion. The unaffected lower limb was not weight-bearing. The tilt table was raised and the participant was instructed to extend the affected lower limb. The highest degree of incline against which the participant could extend the affected lower limb was recorded, where zero degrees indicated that the tilt table was horizontal and 90 degrees indicated that the tilt table was vertical.

Table 2
Baseline characteristics of participants.

Characteristic	Exp (n = 15)	Con (n = 15)
Age *(yr)*, mean (SD)	62 (17)	69 (16)
Gender, n male (%)	9 (60)	8 (53)
Time since ABI *(d)*, median (IQR)	16 (13 to 57)	18 (10 to 34)
Type of ABI, n		
haemorrhage	5	1
infarct	10	14
Affected side, n right (%)	5 (33)	6 (40)
Modified Rankin Scale *(points/7)*, mean (SD)	4.2 (0.4)	4.1 (0.6)

ABI = acquired brain injury, Con = control group, Exp = experimental group.

The Goal Attainment Scale

The original intention was to ask participants to identify one personal goal related to their sit-to-stand ability. However, preliminary testing of this scale indicated that patients with cognitive or verbal impairments had great difficulty setting specific goals. Therefore, the Goal Attainment Scale was modified prior to beginning the trial.[16] Prior to randomisation, a blinded assessor set one goal related to sit-to-stand ability, which was based on their predictions of expected gains in participants' ability to move from sitting to standing over the 2-week intervention period. The assessor who set the initial goal considered the severity of the participant's disabilities and the expected ability of the participant to tolerate therapy. The goal was set according to the SMART principle, that is: the goal was specific, measurable, attainable, realistic and timely. A blinded assessor rated attainment of the goal at the 2-week assessment. The goal was rated on a 5-point scale, where '0' denoted the expected level of achievement; '+1' and '+2' were respectively 'a little' and 'a lot' better than expected, whilst '−1' and '−2' were correspondingly 'a little' and 'a lot' less than expected. A higher score reflected better achievement of goals than a lower score.

Ranking of change in ability to move from sitting to standing

Two blinded assessors separately ranked the change in the participants' abilities to move from sitting to standing in order from most improved to least improved. The assessors used the videos collected as part of the primary outcome to determine each participant's ranking. Scores were combined and averaged to minimise the impact of extreme scores.

Data analysis

The sample size was calculated a priori. It was based on an 80% probability of detecting a mean between-group difference of 2/15 on the primary outcome: clinicians' impressions of sit-to-stand change. The power calculation assumed a drop-out rate of 15%, a power of 80%, an alpha of 0.05, and a strong correlation (0.8) between initial and final values. It was based on an estimated SD of 1.5 derived from a previous study.[17]

Each outcome was analysed using a linear regression approach with baseline data as a covariate. The purpose of these analyses was to determine the effect of the intensive sit-to-stand training versus usual care on all outcomes. All data were analysed according to the principle of 'intention to treat'. The result for the primary analysis was analysed with respect to the pre-defined minimum worthwhile treatment effects. Minimum worthwhile treatment effects were not set for the secondary outcomes.

Results

Flow of participants through the trial

A total of 478 patients with acquired brain injury were screened from the two hospitals over the trial period. Thirty patients were randomised. The flow of the participants through the trial is illustrated in Figure 1. Table 2 summarises the demographic and clinical characteristics of the participants at baseline. The

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Table 3
Mean (SD) of groups, mean (SD) difference within groups, and mean (95% CI) difference between groups.

Outcome	Groups				Difference within groups		Difference between groups
	Week 0		Week 2		Week 2 minus Week 0		Week 2 minus Week 0
	Exp (n = 15)	Con (n = 15)	Exp (n = 15)	Con (n = 15)	Exp	Con	Exp minus Con
Clinicians' impressions of sit-to-stand change *(points/15)*			4.9 (1.6)	3.3 (2.5)			1.57 (0.02 to 3.11)
Sit-to-stand ability *(points/6)*	2.2 (1.1)	3.2 (1.5)	3.9 (1.7)	4.3 (1.9)	1.7 (1.3)	1.1 (0.7)	0.6 (−0.2 to 1.5)
Composite strength of key muscles of the affected lower limb *(points/15)*	6.9 (3.5)	7.1 (3.0)	8.0 (4.2)	8.1 (3.2)	1.1 (2.2)	1.1 (1.6)	0.1 (−1.4 to 1.5)
Gross lower limb extension strength *(deg)*	21.3 (14.9)	21.7 (10.6)	30.5 (15.3)	24.7 (12.8)	9.2 (7.5)	3.0 (7.5)	6.2 (0.5 to 11.8)
Goal Attainment Scale *(points/5)*			0.7 (1.4)	−0.1 (1.1)			0.7 (−0.2 to 1.7)
Ranking of change in ability to move from sitting to standing[a]			12 (8)	19 (8)			−7 (−1 to −13)

Shaded row = primary outcome. Small anomalies in subtraction are due to the effects of rounding. A positive between-group difference favours the experimental group, except where indicated.
Con = control group, Exp = experimental group.
[a] A negative between-group difference favours the experimental group.

experimental and control groups were similar at baseline. Most participants could not walk or needed a high level of assistance to transfer or walk on admission to the trial.

Adherence to the trial protocol

Adherence to the intervention was good. Experimental participants participated in a median (IQR) of 1920 minutes (1690 to 2273) of physiotherapy over the 2-week intervention period. This equated to a median (IQR) of 137 minutes (121 to 162) per day. Control participants participated in a median (IQR) of 970 minutes (948 to 1088) of physiotherapy over the 2-week intervention period. This equated to a median (IQR) of 97 minutes (95 to 109) per day.

Experimental participants completed a median (IQR) 1252 sit-to-stand repetitions (763 to 1773) over the 2-week intervention period. This equated to a median (IQR) 89 sit-to-stand repetitions (55 to 127) per day. Control participants completed a median (IQR) 365 sit-to-stand repetitions (164 to 514) over the 2-week intervention period. This equated to a median (IQR) 37 sit-to-stand repetitions (16 to 51) per day. The assessors remained blinded for all assessments. There were no adverse events.

Effect of sit-to-stand training

Primary outcome

The mean between-group difference for clinicians' impressions of sit-to-stand change was 1.57/15 points (95% CI 0.02 to 3.11) (Table 3). The upper end of the 95% CI associated with the mean between-group difference for this outcome exceeded the minimum worthwhile treatment effect of 2 points, indicating uncertainty as to whether the treatment effect was clinically worthwhile. Individual participant data for this and the secondary outcomes are presented in Table 4 on the eAddenda.

Secondary outcomes

The results for the secondary outcomes are presented in Table 3. The mean between-group difference for sit-to-stand ability was 0.6/6 points (95% CI −0.2 to 1.5). The mean between-group difference for composite strength of the key muscles of the affected lower limb was 0.1/15 points (95% CI −1.4 to 1.5). The mean between-group difference for gross lower limb extension strength was 6.2 deg (95% CI 0.5 to 11.8). The mean between-group difference for the Goal Attainment Scale was 0.7/5 points (95% CI −0.2 to 1.7). The mean between-group difference (95% CI) for ranking of change in ability to move from sitting to standing was −7 (95% CI −1 to −13) in favour of the experimental group, supporting the results of the primary outcome.

Discussion

The results of this trial indicate that intensive sit-to-stand training in addition to usual care improves sit-to-stand ability in people who are unable to stand up independently after stroke (Table 3). This trial provides the first evidence that as little as 2 weeks of additional repetitive sit-to-stand training in the early stages of stroke recovery may be worthwhile.

There have been trials investigating the effects of additional repetitive sit-to-stand training; however, some of these trials only recruited people who could stand up without assistance.[9,10,12] Barreca et al specifically recruited people who could not stand up independently after stroke; however, this trial had methodological issues affecting the validity of the results.[8] Interestingly, Barreca et al demonstrated a treatment effect with a small difference in daily sit-to-stand repetitions between their experimental and control groups: median 15 repetitions (IQR 12 to 20) versus 11 repetitions (IQR 8 to 17), respectively. This improvement with such a small difference in daily sit-to-stand repetitions between groups conflicts with recent evidence[6] indicating that large amounts (more than triple the usual amount) of additional training are required to improve functional outcomes after stroke. In comparison, participants in the experimental and control groups in our trial performed a median of 89 (IQR 55 to 127) versus 37 (IQR 16 to 51) daily sit-to-stand repetitions, respectively. Overall, participants in our experimental group performed over three times more sit-to-stand repetitions than participants in our control group; median (IQR) 1252 repetitions (763 to 1773) versus 365 repetitions (164 to 514), respectively. It is unclear how Barreca et al demonstrated a treatment effect with such a small difference in sit-to-stand repetitions between their experimental and control groups. However, there are two possible explanations: they may have under-reported the total amount of sit-to-stand repetitions in their experimental group or it may be that less additional training is needed to improve sit-to-stand than other tasks (such as reaching and manipulation) in people after stroke. We developed our protocol on the hypothesis that large amounts of sit-to-stand repetitions are needed to improve sit-to-stand ability; however, we may have provided more training than is required. A further trial comparing different amounts of sit-to-stand repetitions is needed to further explore this issue.

While our trial demonstrated a treatment effect of additional sit-to-stand training, there is uncertainty as to whether the size of

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this effect is clinically worthwhile. This is due to the imprecision of the estimate associated with the between-group difference. The upper end of the 95% CI exceeded the pre-determined clinically worthwhile treatment effect of 2/15 points. A larger sample size would have provided more precision and possibly more clarity around whether the treatment was worthwhile.

It is possible that a larger treatment effect would have been found if there had been better control of contamination between groups. Physiotherapists may have unintentionally incorporated some of the experimental strategies to improve sit-to-stand ability with participants in the control group. This potential contamination may have increased the amount of training provided to control participants, thereby decreasing the difference between the two groups. Prior to the start of the trial, we considered treating experimental participants in a separate area to avoid contamination. However, this was not feasible. To minimise contamination, the same physiotherapist provided all the interventions to participants in the experimental group and great care was taken to keep experimental participants naïve to the purpose of the trial. Whilst experimental participants were clearly participating in the additional training, they were unaware that the content was different to usual care. Similarly, attempts were made to keep the therapists responsible for treating the control participants naïve to the purpose of the trial. Despite the potential contamination, a treatment effect was still demonstrated.

We administered intensive sit-to-stand training over 2 weeks. We chose 2 weeks because people often only remain in rehabilitation for this period and we were interested to know whether it is worth administering intensive sit-to-stand training if it can only be provided for such a short length of time. The results indicate that this intervention is effective for people who only receive 2 weeks of rehabilitation after stroke. It may be that larger amounts of sit-to-stand training over a longer period would have produced even greater results. The other reason we administered the treatment for 2 weeks was that we were concerned that participants would not tolerate such an intensive intervention each day for more than 2 weeks, particularly in the early stages of stroke recovery. However, we found that the experimental participants were able to tolerate large amounts of sit-to-stand repetitions, suggesting that our concerns were unfounded.

One of the challenges prior to the start of this trial was finding an outcome measure that would be appropriate for people with all levels of disability and particularly those who were very disabled. Most outcome measures of sit-to-stand ability are susceptible to floor effects in people who are too disabled to stand up. To overcome this problem, we used a novel method to assess sit-to-stand ability: clinicians' impressions of change of participants' ability to move from sitting to standing from videos. Two blinded assessors were asked to score the change in ability of participants to perform an independent sit-to-stand movement, taking into consideration the initial disability of the participant and the amount of change expected over a 2-week period assuming the participant received usual care. This way, small functional changes that are often missed by other outcome measures could be detected. A limitation of this outcome measure is that it is somewhat subjective and relies on the clinicians' understanding of likely change in ability to move from sitting to standing over a 2-week period after taking into account the severity of participants' disabilities. We used two assessors and averaged their scores to minimise the impact of extreme scores. Interestingly, the results of one of the secondary outcomes, which also relied on the scores from videos, gave similar results. Taken together, the results of these two outcomes add weight to the potential value of relying on clinicians' impressions of change of participants' ability to move from sitting to standing from videos.

This trial provides insights into the possible mechanisms underlying the observed improvements in sit-to-stand ability. That is: repetitive practice of sitting to standing improves lower limb strength, which in turn improves sit-to-stand ability. Interestingly, there was no suggestion of a between-group difference for composite strength of key muscles of the affected lower limb. In contrast, the between-group difference for gross lower limb extension strength of the affected lower limb suggested a treatment effect (6.2 deg, 95% CI 0.5 to 11.8). These conflicting results of voluntary muscle strength may highlight the lack of sensitivity in the manual muscle test scale used to assess composite strength of key muscles of the affected lower limb. The improvements in gross lower limb extension strength of the affected lower limb suggest that the observed improvement in sit-to-stand ability may, in part, be explained by an improvement in lower limb extensor strength. This finding aligns with other studies of repetitive practice after stroke.[18]

We planned to use the Goal Attainment Scale to assess if participants could achieve personal goals related to sit-to-stand ability. However, preliminary testing of this scale indicated that patients with cognitive or verbal impairments had great difficulty setting specific goals. Therefore, we modified the goal-setting procedure for the Goal Attainment Scale prior to beginning the trial. Prior to randomisation, a blinded assessor set one goal related to sit-to-stand ability, which was based on his/her predictions of expected gains in participants' ability to move from sitting to standing over the 2-week intervention period. Similar to the primary outcome measure, the assessor who set the initial goal took into account the severity of the participants' disabilities and expected ability of participants to tolerate therapy. The results for the Goal Attainment Scale did not suggest a treatment effect; however, these findings may point to problems with the way the Goal Attainment Scale was used in this trial.

Some clinicians may view the inclusion of participants with varying levels of cognition, aphasia, and lower limb strength as a limitation. If those who are weaker and more disabled benefit more than those who are stronger and less disabled, then the inclusion of people who were less disabled may have reduced the treatment effect. However, we see this as a strength and not a limitation in our trial. Participation was not limited to a more disabled group of people because we were interested in generalising the results to typical patients admitted for rehabilitation after stroke. However, only participants who were unable to stand up independently were included in the trial.

The results of this trial are important because up until now there has been uncertainty regarding the effectiveness of additional repetitive sit-to-stand training in people who are unable to stand up independently after stroke. Since standing up independently is essential for reducing disability and burden of care, attaining independence in sit-to-stand ability is a high priority. However, there can be many tasks to train after stroke, and it can be difficult for clinicians to prioritise which tasks to train first. One possible implication of our results is that 2 weeks of intensive repetitive sit-to-stand training could be initially prioritised for people with difficulty standing up, allowing more time after this period to focus on other tasks requiring independent sit-to-stand ability, such as walking.

In summary, this trial provides evidence that as little as 2 weeks of intensive sit-to-stand training in addition to usual care improves sit-to-stand ability in people who are unable to stand up independently after stroke. This trial also demonstrates that large amounts of sit-to-stand training is well tolerated in the early stages of stroke recovery. Future larger trials should clarify the effects of longer training periods or different amounts of sit-to-stand repetitions, and determine if the observed effects are clinically worthwhile.

What was already known on this topic: After stroke, many people have difficulty standing up independently. Repetitive training improves functional tasks, but existing trials of repetitive sit-to-stand training have important limitations.

What this study adds: Two weeks of intensive sit-to-stand training in addition to usual care improves sit-to-stand ability in people who are unable to stand up independently after stroke. However, it is not clear whether the size of the treatment effect is clinically worthwhile. Large amounts of sit-to-stand training are well tolerated in the early stages of stroke recovery.

eAddenda: Table 4 can be found online at: https://doi.org/10.1016/j.jphys.2019.05.007.

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Ethics Approval: The study was approved by the Northern Sydney Local Health District Human Research Ethics Committee. Written consent was obtained from all participants or their next of kin before data collection began.

Competing interests: Nil.

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