How Health Services Research Can Translate to a Better Future: Singapore's Tele-Rehabilitation Experience

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Research

Clinical Care

Education

Post-Stroke Functional Recovery in Singapore

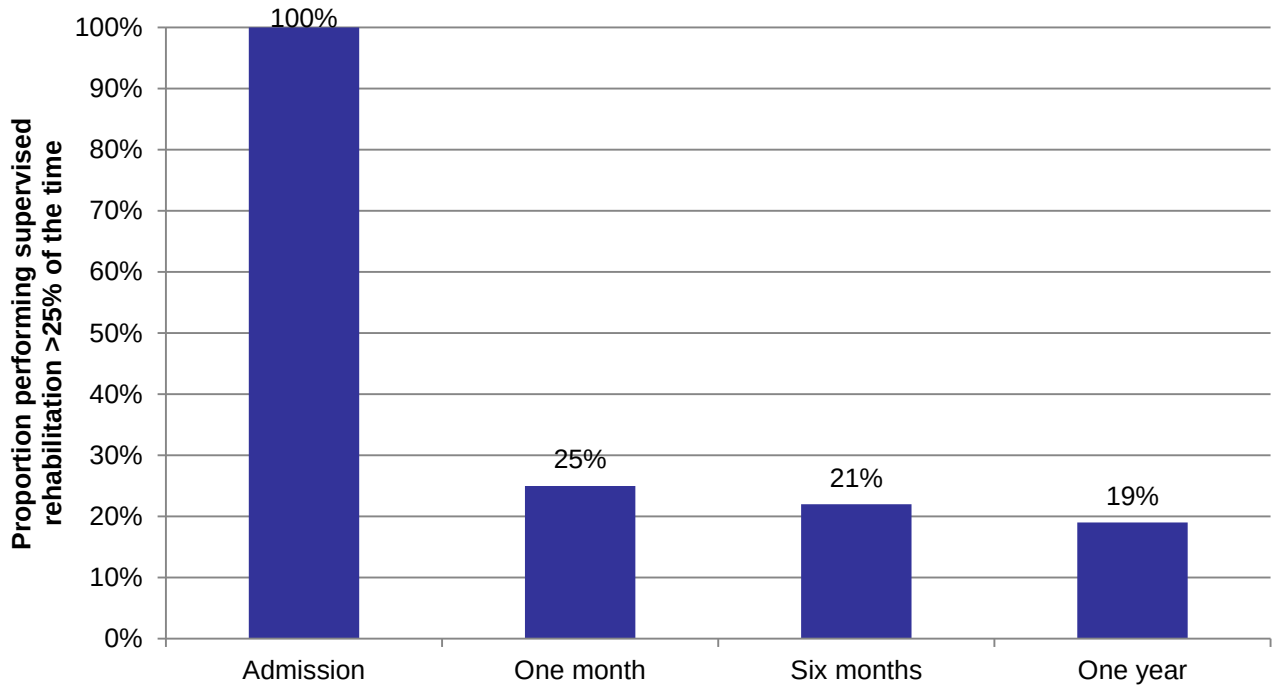
- Greater participation in supervised rehabilitation at day rehabilitation centre >25% of time at 1 and 6 months independently predicted higher Barthel Index (BI) scores 1 year by 25%, adjusted for baseline function, socio-demographic variables, cognition, depression, stroke severity & other variables.
- Unsupervised rehabilitation at home had no effects on function at 1 year.

	Adjusted Mean BI Score at 1 Year (95% CI)	Adjusted β-estimate (95% CI)	p-value
Performing therapy at home			
One month			
> 75% of the time	64.7 (54.0 – 75.3)	-4.7 (-10.5 – 1.0)	0.103
≤ 75% of the time	69.4 (58.5 – 80.3)	-	
Six months			
> 75% of the time	67.5 (56.8 – 78.2)	1.0 (-5.0 – 7.0)	0.729
≤ 75% of the time	66.5 (55.6 – 77.4)	-	
Performing therapy at outpatient rehab centre			
One month			
> 25% of the time	72.4 (61.6 – 83.1)	10.7 (3.3 – 18.2)	**0.006**
≤ 25% of the time	61.7 (50.3 – 73.0)	-	
Six months			
> 25% of the time	**74.7** (64.1 – 85.3)	15.3 (7.1 – 23.5)	**0.001**
≤ 25% of the time	**59.4** (47.7 – 71.1)	**-**	

Koh GCH, Saxena SK, Ng TP, Yong D, Fong NP. The effect of duration, participation rate and supervision during community rehabilitation on functional outcomes in the first post stroke year in Singapore. *Arch Phys Med Rehabil* 2012;93:279-86.

Performance of Rehabilitation after Discharge

- The proportion of stroke patients performing supervised rehabilitation at day rehabilitation centre after discharged dropped to 25.3% at 1 month and declined to 19.0% by 1 year.



Performance of Rehabilitation after Discharge

- Performance of rehabilitation in day rehabilitation centre at 1 month was very strongly predictive of performance of supervised rehabilitation at 6 months and 1 year.

Variables	Adjusted OR (95% CI)	p-value
At one month		
Age >75 years (vs. ≤75 years)	0.43 (0.20 – 0.91)	0.028
At six months		
Caregiver availability (vs. none)	0.07 (0.01 – 0.49)	0.007
Performance of supervised therapy >25% of the recommended time at 1 month	**11.64** (4.52 – 29.97)	<0.001
At one year		
Performance of supervised therapy >25% of the recommended time at 6 months	**76.46** (12.52 – 466.98)	<0.001

Koh GCH, Lim DYY, Zhang SL, Chen C, Saxena SK, Fong NP, Yong D, Ng TP. Predictors of participation in supervised therapy by post-stroke patients in the Singapore community: a one-year cohort study. *Singapore Family Physician 2015*;41:63-74.

Why Patients Do Not Go for Rehabilitation in Singapore

- Although the majority (76.8%) acknowledged that inpatient rehabilitation was beneficial, only 40.0% wanted to continue with rehabilitation after discharge.
- The barriers to adherence with rehabilitation after discharge were:
  - Functional
  - Social
  - Financial

Chen AWL, Koh YT, Leong SWM, Ng LWY, Lee PSY, Koh GCH. Post-community hospital discharge rehabilitation attendance: Self-perceived barriers and participation over time. *Ann Acad Med Singapore* 2014;43:136-44.

Functional Barriers

Problems with ambulating from home to rehabilitation centre 62%

Problems with ambulating within the home 21%

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Going up: Calls for lift upgrades

blocks in Singapore, which were built more than 16 years ago, do not have lifts that stop at every floor.

Former HDB chief architect Tony Tan, who was with the board from 1968 to 2003, says it was too costly to have lifts stopping at every floor in the early years, when the more urgent need was to house the masses in affordable flats.

But the designers had an eye on the future, he says. The blocks were built with a lift shaft which could, by knocking out the wall at each level, allow the lift to stop at every floor.

HDB took the decision to build flats with lifts stopping at every floor after 1988, to cater to the needs of the aged.

Another pressing concern: How to prevent older estates from becoming derelict ghettos should residents move away to newer and better neighbourhoods.

So, from 1989, some blocks over 17 years old were upgraded via the Main Upgrading Programme. Extra space was added to flats, covered linkways and other frills were built, and the existing lift shaft was used to install lifts which stopped at every floor.

Four years later, the Interim Upgrading Programme saw to it that blocks aged 10 to 17 years had their exteriors and surroundings improved.

In the 1997 general election, the People's Action Party government made it clear that those who supported the party at the polls would be upgraded first.

In its latest move, the Government has announced an accelerated $5 billion-plus Lift Upgrading Programme, which aims to have lifts stopping at every floor of HDB blocks by 2014, in view of the rapidly ageing population.

In 1993, 5.7 per cent (136,652) of HDB residents were aged 65 and above; in 2003, it was 7.6 per cent (217,568). The figure is expected to more than double to 18.1 per cent by 2030.

PHOTO: CHEW SENG KIM

A BETTER LIFT, PLEASE: Ms Tay carries her grandmother on her back from the ninth floor lift to her grandmother's 10th-floor home. The 82-year-old woman is wheelchair-bound following a stroke.

MP Teo Ho Pin recalls that, in a visit to his Bukit Panjang ward two years ago, he was shocked to find five wheelchair-bound, elderly residents in just one HDB block.

"They said: 'Please, it's important that we get the lifts quickly. If not, by the time you do it, we may be gone.' "

Residents clearly want the new lifts: Up to last month, 821 out of 851 HDB blocks polled for lift upgrades had garnered the required 75 per cent of votes needed from residents to proceed.

Interest in the main upgrading programme, though, seems to have waned in some quarters. A smaller number of four- and five-room flat owners voted for the extra space — from three out of 17 blocks in the financial year 2000, to one out of 17 blocks two years later.

Some residents prefer to be moved en-bloc to new and better flats. Others do not want to incur the expenses.

Although HDB subsidises at least 75 per cent of upgrading costs, the main upgrading programme can cost a household between $2,000 and about $30,000, while lift upgrading is capped at $3,000 per household. A new way to install lifts is expected to cut costs by up to 20 per cent.

HDB itself is also focusing on lift and interim upgrading. With the same budget, this means picking fewer precincts for the more costly main upgrading programme — six in financial year 2005, compared to 10 in that of 2002 — and offering extra space only for three-room flats.

Lifts are a key item in the multi-million dollar, five-year estate renewal plans announced in recent months in the run-up to the general election.

Lift upgrading makes up 15 per cent to over half of the value of the GRCs' plans.

In Aljunied, it is $65 million; Holland-Bukit Panjang, $116.2 million; Tanjong Pagar, $145 million; Hong Kah, about $150 million; Jurong, $200 million;, East Coast, $200 million; Tampines, $200 million; Marine Parade, $241 million; and Sembawang, $336 million.

Lift upgrading is so coveted that MPs have to explain to residents why their blocks will be upgraded later than others.

As Dr Teo notes: "Everybody wants it by yesterday."

As grassroots advisers, MPs recommend to the authorities which of their precincts should be upgraded first. Older flats with more elderly people are top priority.

The complexity of installing a lift matters too. Some blocks require only one extra lift shaft. Those without a common corridor need more.

How the blocks are arranged is another factor. An isolated block that needs a lift upgrade may have to wait for the area to be upgraded under the interim programme to avoid inconvenience to other blocks.

Lift upgrading is a trump card in Hougang and Potong Pasir. PAP candidates look set to say they will lobby for it. Opposition MPs cry foul that they were not allowed to use their sinking fund to pay for lifts that stop at every floor over the past few years. A change to the law last August, however, permits them to use 10 per cent of the fund for lift upgrading if the cost to each flat does not exceed $5,000.

Mrs Gurdeep Singh, 51, who lives in Potong Pasir, does not think residents will be denied lift upgrading for not voting for the PAP.

The lift in the block where she lives, on the 17th floor, stops at the 16th. It is inconvenient for her, as her left foot has been amputated.

But she said: "We'll get upgrading sooner or later. After all, we're citizens of Singapore and everybody needs a lift."

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"It's very hard to get around… Upgrading works are in progress around my home at the moment. Now, I have to take a lift to the fifth floor before taking the stairs to the third storey where I live."

[62-year-old Chinese female]

Functional Barriers

Problems with ambulating from home to rehabilitation centre	62%
Problems with ambulating within the home	21%

Social Barriers

Inconvenient for subject	57%
No caregiver available to accompany subject	31%
Subject does not wish to burden caregiver	29%
Inconvenient for caregiver	21%
Caregiver is too busy	19%
Subject is too busy	12%

"I am afraid I might fall again if I go alone. However, I would like to continue rehabilitation if I can."

[69-year-old Chinese male]

"There is no one to bring me for my rehabilitation sessions if there will be any. However, I would like to continue rehabilitation if I am able to do so as I find it good and useful."

[74-year-old Chinese female]

Financial Barriers

Financial problems from out-of-pocket payments	29%
Financial problems from high cost per session	21%
Financial problems from long duration of rehabilitation	5%

"I think (the cost of rehabilitation) will be okay for the first few weeks but will be a problem if it goes beyond that. After all, I already have to pay for my (other medical) bills."

[62-year-old Chinese female]

"Money is an important factor. I am concerned that I cannot use Medishield or Medisave (government insurance) for physiotherapy and transport. I currently have no income, thus I cannot pay."*

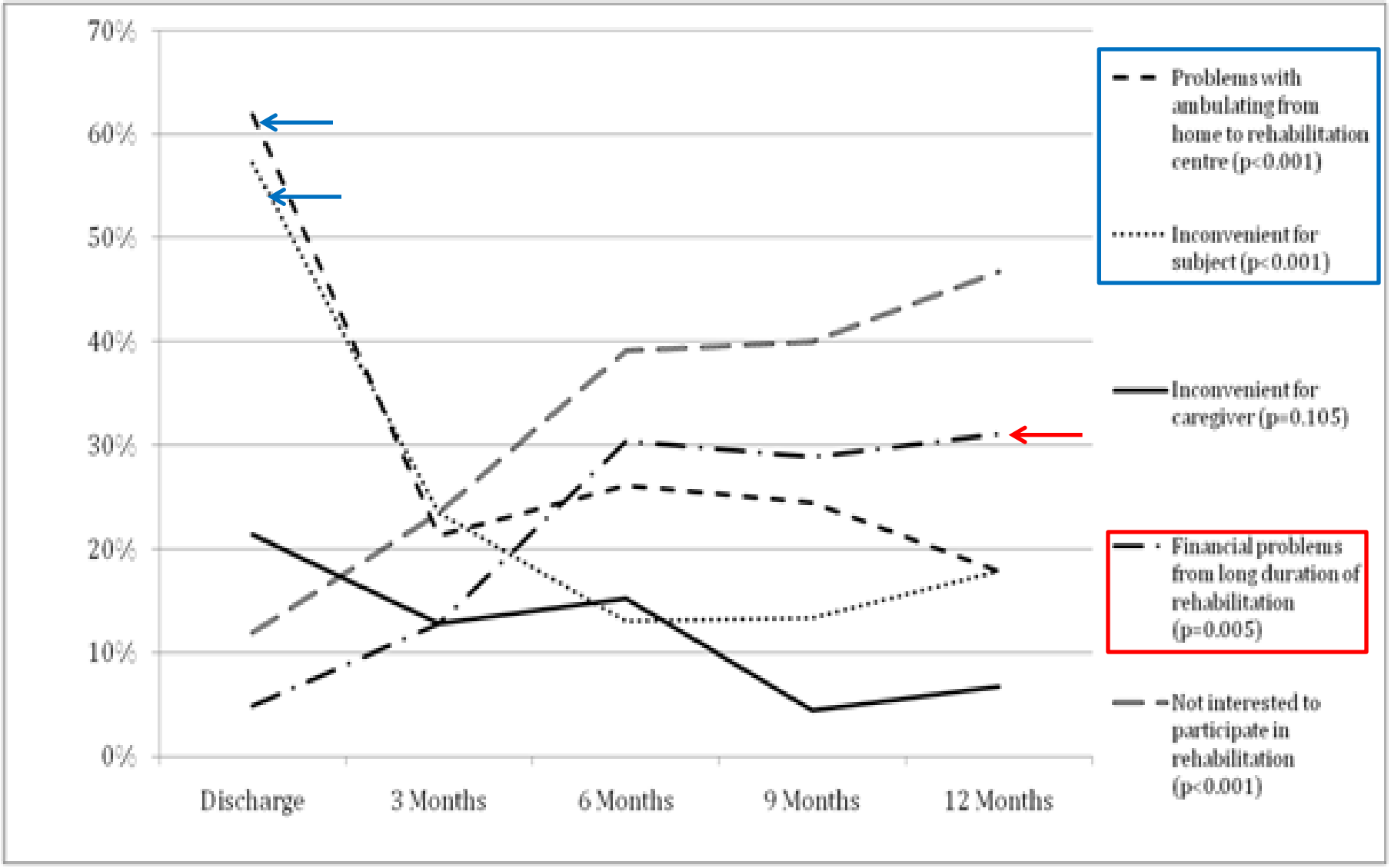
[52-year-old Indian male]

* From July 2012, Medisave was allowed to be used for day rehabilitation up to S$20 per day, subject to a maximum of S$1,500 a year.

Financial Barriers

	Specialist Outpatient	Day Rehabilitation Centre
Cost per Visit	$150 per visit	$50 per visit
Ratio of Cost Per Visit	3 : 1	
No. of Visit Over 3 Months	1 visit	Twice a week X 12 weeks = 24 visits
Total Cost Over 3 Months	$150	$1,200
Ratio of Cost for Visits Over 3 Months	1 : 8	

How Did Barriers to Rehabilitation After Discharge Change with Time?



How Can We Increase Adherence to Rehabilitation?

Home Rehabilitation?

Advantages

- No need for patient to overcome physical barriers
- No need for caregiver to take time off to accompany patient to rehabilitation centre (but will need to be present during tele-rehabilitation)

However…

- Currently, there are means-tested subsidies available
- Cost = $150 per visit X 2 visits a week
  = $3,600 over 12 weeks (3 months)
- 3X more expensive than centre-based rehabilitation

How Can We Increase Adherence to Rehabilitation?

Tele-Rehabilitation?

Advantages

- Therapist does not need to visit patient at home
- No need for patient to overcome physical barriers
- Caregiver need not go to rehabilitation centre
- May be provided after office hours

However…

- Currently no public subsidies in Singapore
- Estimated cost = $125 per week = $1,500 over 3 months
- Just slightly more expensive than centre-based rehabilitation
- Caregiver needs to be present during rehab and video-conference session

Studies on Telerehabilitation

Current published trials on tele-rehabilitation have used a combination of:

- Home visits
- In-home messaging device ->
- Telephony
- *Store-and-forward* video recording by therapy aide during home visits

However:

- Still require face-to-face home visits which are expensive
- Does not leverage on *live (real-time)* video-conferencing which is more cost-effective and efficient
- No physical data collected
- Unlike in tele-psychiatry & tele-dermatology, tactile data is important in tele-rehabilitation

Chumbler NR, Quigley P, Li X, Morey M, Rose D, Sanford J, Griffiths P, Hoenig H. Effects of telerehabilitation on physical function and disability for stroke patients: a randomized, controlled trial. Stroke. 2012:2168-74.

Tele-Rehabilitation

Can we use instead:

- *Training* for patients & caregivers on use of telerehabilitation system before discharge to home;
- *Live real-time video-conferencing* (e.g. FaceTime on iPads);
- *Sensors* to capture *physical data* to help therapists assess recovery process and prescribe next level of exercises;
- *Pushing training videos of* therapist-prescribed exercise *to patients*?

Tele-Rehabilitation

- Since 2010, National University of Singapore has been developing a tele-rehabilitation system in collaboration with acute and community hospitals in Singapore
- Incorporates previously mentioned elements
- Its effectiveness is currently being evaluated in a randomized controlled trial.
- Its efficiency was evaluated in a time motion study.

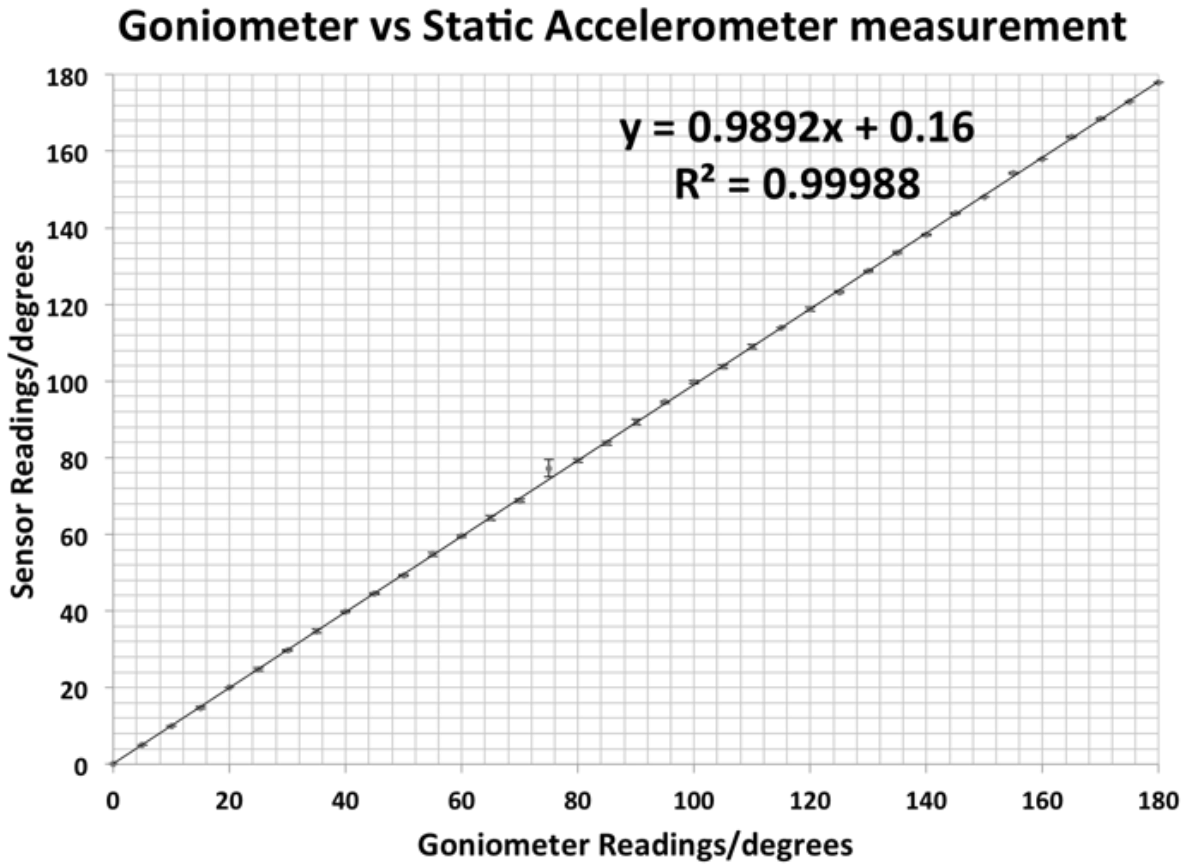
Mdm Doris Zen's Story

(1:48)

How the Tele-Rehab System Works

(1:11)

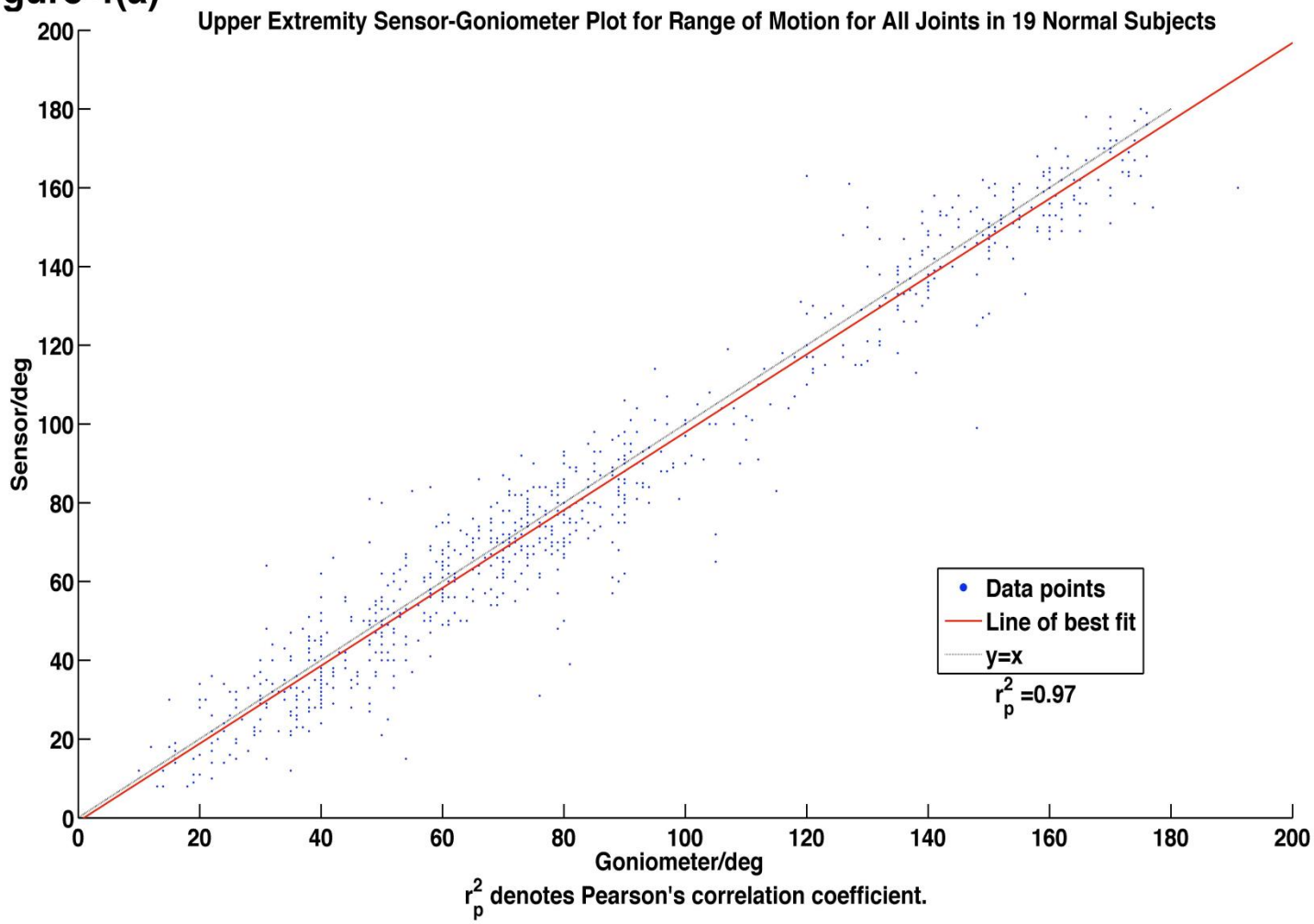
Accuracy of Sensors



Kumar Y, Yen SC, Tay A, Lee WW, Gao F, Zhao ZY, Li JZ, Hon B, Xu TTM, Cheong A, Koh K, Ng YS, Chew E, **Koh GCH**. A wireless wearable range-of-motion sensor system for upper and lower extremity joints: A validation study. *Health Technology Letters*. 2015.

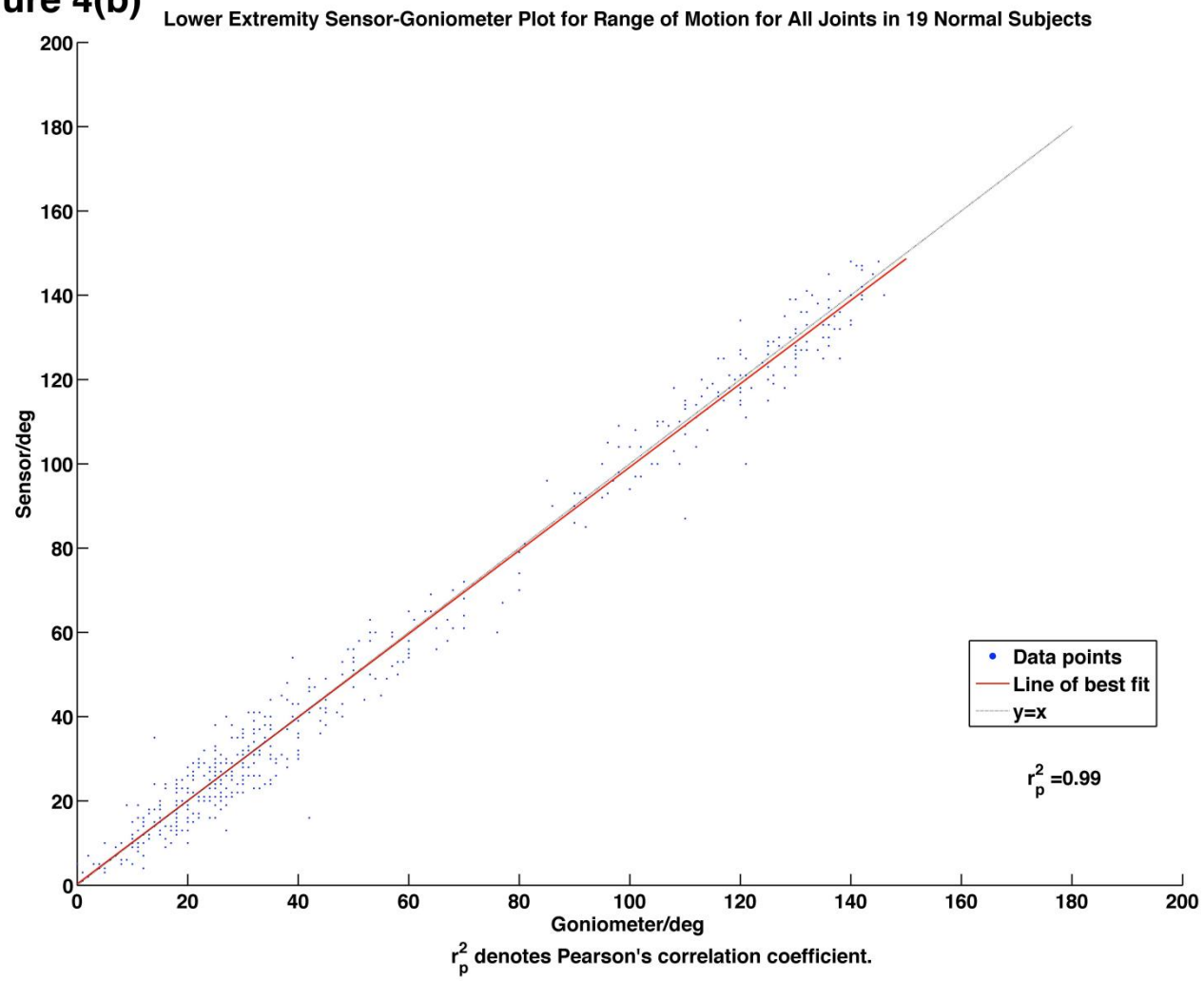
Accuracy of Sensors (Upper Extremities, UE)

Figure 4(a)



Accuracy of Sensors (Lower Extremities, LE)

Figure 4(b)



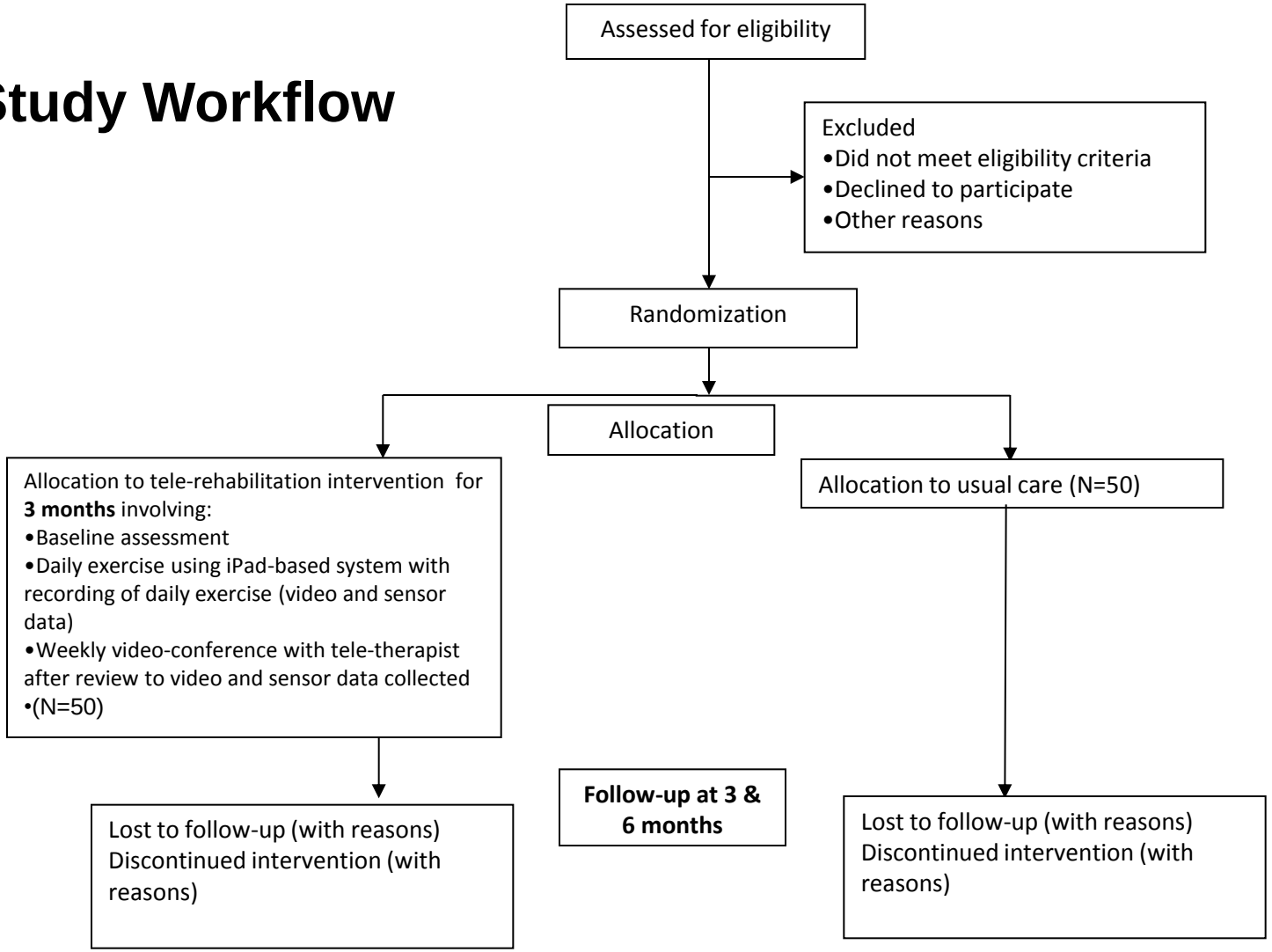
Singapore Tele-technology Aided Rehabilitation in Stroke (STARS) Study: A Randomized Controlled Trial

Primary hypothesis

Among stroke survivors, a tele-rehabilitation intervention involving video-conferencing with a therapist and use of wearable monitoring devices during the first three months after stroke results greater functional recovery at three months, compared to usual care.

Koh GCH*, Yen SC, Tay A, Cheong A, Ng YS, De Silva DA, Png C, Caves K, Koh K, Kumar Y, Phan SW, Tai BC, Chen C, Chen ZJ, Chua CE, Koh YS and Hoenig H. Singapore Tele-technology Aided Rehabilitation in Stroke (STARS) trial: Protocol of a Randomized Clinical Trial on Tele-rehabilitation for stroke patients. *BMC Neurology*.

Study Workflow



Preliminary Results

- The primary time-point for outcomes in the RCT is 3 months and the target size is 50 controls and 50 intervention subjects.
- These are the results of an interim analysis of 30 subjects recruited so far (14 control and 16 intervention subjects) as of end 2014.
  - Of the 14 control subjects, 2 subjects defaulted follow-up, leaving 12 control subjects available for analysis for data at 3 month time-point.
  - Of the 16 intervention subjects, 2 subjects defaulted follow-up, leaving 14 intervention subjects available for analysis for data at 3 month time-point.
- Statistical significance cannot be assessed in this interim analysis because target sample has not been reached and hence current sample size is not powered.
- This interim analysis only reports preliminary primary findings.

Difference in Barthel Index (BI) score between baseline and three months

Group	Mean Change	Interpretation
Usual Care	-0.75	The tele-rehabilitation group improved in the functional status by 9.07 BI points while the usual care declined by 0.75 BI points.
Tele-rehabilitation	+9.07	

[Barthel Index (BI) ranges from 0 to 100. The higher the improvement in Barthel Index score, the greater the functional improvement.)

Difference in Barthel Index (BI) score between baseline and six months

Group	Mean Change	Interpretation
Usual Care	+2.4	The tele-rehabilitation group continued to improve between 3 and 6 months, even after tele-rehabilitation ended at 3 months.
Tele-Rehabilitation	+11.50	

(Barthel Index (BI) ranges from 0 to 100. The higher the improvement in Barthel Index score, the greater the functional improvement.]

Attendance at day rehabilitation centre during study

- At recruitment, 41.7% of controls were going for day rehab but only 14.3% of telerehab subjects were going for day rehab which is expected as the telerehab group were already receiving telerehab.
- In contrast, at three months, 33.3% of controls were going for day rehab (a drop from 41.7%) but 64.3% of telerehab subjects (an increase from 14.3%) continued rehabilitation (after telerehab stopped) by going for day rehab.

Time Motion Study Results

	Mean Time Spent per Therapist Session (mins)	
	Therapist	**Caregiver**
Day Rehabilitation	70	135
Home Rehabilitation	86	12
Tele Rehabilitation	30	15

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