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Media Release

NUHS leads study of using exoskeleton technology to improve rehabilitation from hospital to community

The National University Health System (NUHS) and Alexandra Hospital (AH) partner with Temasek Foundation (TF) and Trailblazer Foundation Limited (TFL) in Asia's first clinical study on the use of advance rehabilitation technology, namely bionic exoskeletons, within and beyond the hospital, so as to improve patients' mobility.

1 Monday, 6 May 2019 – NUHS is the **first national health system**, to lead in Asia's first clinical study of using bionic exoskeletons in rehabilitation to help patients with impaired mobility and speed up patient recovery within and beyond hospital settings. Launched this morning by Mr Chan Heng Kee, Permanent Secretary of Ministry of Health, the **Temasek Foundation - Improving Mobility via Exoskeletons (iMOVE) programme**, will study **patient outcomes and assess the viability, sustainability and potential for scaling-up the use of robotic exoskeletons across the continuum of rehabilitation care** – from the hospital to the community, for patients, especially the elderly (at inpatient and outpatient hospital settings, and in day rehabilitation centres and nursing home), suffering from **stroke, spinal cord injuries, and other causes of physical disabilities, to improve** mobility and independence. This is a two-year partnership between NUHS, TF and TFL, and taking place at sites, namely, **Alexandra Hospital (AH), NTUC Health, St Luke's Eldercare (SLEC), St Luke's Hospital (SLH) and Stroke Support Station (S3)**¹.

2 In Singapore, stroke is the leading cause of long-term disability and loss of mobility, especially amongst the seniors. Singapore faces an annual increase of some 7,000 new cases of stroke alone, per year, or 20 new strokes a day, of which about 15% - 20% will benefit from robotics rehabilitation at the hospital or community-based care. More than 65% of stroke survivors have impaired ability to walk and 30% have long-term motor deficits.

3 Suresh Ramaswamy, a senior Physiotherapist of AH said, "The device helps me to optimize a 45-minutes therapy session with my patients. It provides good support to the hip, knee and ankle joints. This allows the patient to confidently take more steps within a shorter duration

¹ S3 will be deploying the exoskeleton at their new centre at Jurong Point from 28 May 2019.

as compared to other methods. The exoskeleton device has multiple features which can cater to various walking issues from different conditions such as spinal injury and stroke. Exoskeleton technology is also more manpower-efficient. For patients who are unable to walk independently, training with an exoskeleton reduces the number of therapists required compared to conventional physiotherapy. For example, in conventional physiotherapy, two therapists may be required to walk patients with more severe physical impairments with much difficulty. On the other hand, one physiotherapist and extra help by a caregiver is sufficient to walk the same patient with exoskeleton device much more efficiently. The patient may also be directly involved in being engaged during the session to operate the control pad's commands of 'stop', 'start' and 'turn'. This over-the-ground device provides instantaneous data of various joint movements and the patient's degree of dependence on the device. With such data, I can adjust the parameters to challenge the patient within the same session. Moreover, this device does not permit compensatory movements and ensures focused steps during walking according to the pre-programmed parameters." Twelve physiotherapists from AH, SLH, SLEC and NTUC Health, across the island have been trained to use the exoskeleton in this programme so far.

4 Mr Henry Tan, 66, a retired engineer, has congenital muscle dystrophy and walked with a hunch and a very poor gait pattern with a stick, before suffering a stroke in October last year. After his stroke, he was wheelchair bound, and had completely no strength on his right side. The device helped to address these two conditions he has. After eight sessions, Henry can stand straighter with a better gait pattern than he had for more than 20 years, besides regaining the function in his paralysed limbs. "This over-the-ground device is 'unforgiving' and forces me and teaches me to walk properly through its resistance and assistance modes and I can overcome my propensity to fall over by addressing my poor gait patterns which I had not been able to achieve using other methods." ([Read more patient experience in appendix](#)).

5 Dr Effie Chew the Chief of Rehabilitation Services at AH, and a senior consultant in Rehabilitation Medicine, Department of Neurology, NUH, leading the study, hopes to recruit 400 patients in this study by September next year. To-date, more than 65 patients have been put on the exoskeleton. "With this study, we hope to give patients the best chances of achieving their fullest potential in recovery with the help of the latest in rehabilitation technology. It is part of our continued efforts to tailor effective treatment to suit our local context and to make them accessible to all patients with disabilities. We have had good initial experience with the technology, with better and faster improvement in mobility for some of our patients and hope to see the benefits brought to more patients in the community."

6 Temasek Foundation and Trailblazer Foundation Limited have committed a grant of S\$1.34 million to support this programme. Mr Richard Magnus, TF Chairman explained, "The exoskeleton is a game changer in physical rehabilitation. For seniors with mobility difficulties, the exoskeleton helps them to stand and to walk. The patient recovers confidence in walking and has a better quality of life. In the short period of time since the start of this programme, we have seen encouraging and inspiring improvement in patient outcomes. An elderly gentleman who had been bedridden for years could stand and take steps with the use of this technology! Through this programme, we hope to make exoskeleton-enabled rehabilitation accessible and affordable to more seniors in the community."

7 Chief Executive of NUHS, Professor John Wong Eu Li said, "iMOVE is very much in keeping with NUHS's model of close partnership with like-minded organisations in the community as we strive to harness technology to improve quality, affordable, and accessible healthcare."

8 ARTSIG, a national taskforce was also inaugurated this morning, as a concerted effort to advance knowledge and use of technology in rehabilitation. Members of the rehabilitation community, including doctors, therapists, engineers, nurses and the care teams, are members of this special interest group named Advance Rehabilitation Technology Special Interest Group (“ARTSIG”) under the auspices of the Society of Rehabilitation Medicine, Singapore (SRMS), to collaborate and regularly come together for knowledge exchange, and collaborate on technology-related projects, to enhance rehabilitation outcomes for everyone.

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About robotic exoskeleton:

Exoskeleton technology is an emerging innovation that can improve outcomes over a shorter period of time for patients with mobility difficulties. Exoskeleton technology are task-specific, using robot-assisted gait training which more closely simulates real-life walking. Patients are trained with weight-bearing, weight-shifting, stepping and balancing skills in their legs. Using exoskeleton technology, patients can achieve an average of more than 500 steps in a 20-minute gait training session compared to 50 to 100 steps in conventional rehabilitation. Exoskeleton technology is also more manpower-efficient. For patients who are unable to walk independently, training with an exoskeleton reduces the number of therapists required.

The robotic exoskeleton used in this project is a wearable robotic device which is portable and adjustable, designed to help patients unable to walk due to neurological injuries such as a spinal cord injury or stroke. It is programmed to mimic normal walking patterns and provides powered assistance at the hip and knee with precision, with programmed settings determined by the treating physiotherapist, enabling the individual to stand, walk and turn. The robot senses and responds to weight shifts and patient’s efforts to walk in a specified trajectory, and provides assistance and also resistance to challenge the patient to initiate more power, according to settings determined by the treating physiotherapist. In this way, the device provides consistent feedback to the patient to enhance learning, according to therapist-directed goals, while relieving the manual strain on the physiotherapist performing the training. The physiotherapist is then able to concentrate his attention on the quality of gait and the patient’s efforts in the training, as well as the feedback on patient performance provided the sensors. The exoskeleton can provide immediate feedback during the therapy session by which the patient and therapist can make immediate adjustments to gait and the robotic assistance provided, as well as to determine how to progress training. Such a tool augments the therapist’s efforts in gait training.

How it helps the patient:

Typically, for patients who have acquired disabilities affecting their ability to walk, their journey begins with a devastating illness bringing them to an acute hospital, followed by inpatient rehabilitation, either in a specialist rehabilitation centre or a community hospital, and then outpatient rehabilitation at a day rehabilitation centre until there is no further functional improvement. Studies have shown that the most effective approach to regain the ability to walk is to practise walking. This may be difficult with conventional physiotherapy, particularly for those with greatest disability. The intensity of training also matters, and may also be difficult to achieve with conventional therapy. For those discharged from hospital, another factor compromising recovery is the lack of compliance to continued rehabilitation sessions and exercise. For example, one study in Singapore by Chen et al, published in the Annals Academy of Medicine Singapore in 2014, demonstrated that overall longitudinal attendance rate fell from 100% as inpatient to 20.3% at 3 months and less than 10% at 6 months due to difficulties with access, motivation, and financial concerns. This study looks at how a new technology-based community care model for rehabilitation may change outcomes, whether by improving efficacy, efficiency or motivation and adherence, at different points in the journey of recovery, and to make such devices as accessible as possible to all patients who need it, through our community partners across the island.

Patient profiles:

Patients are on the exoskeleton (min. 12 sessions).

a) Mr Gandhi Mailvahanam, 65, a former marathoner, suffered a traumatic injury 8 years ago, and had been bed-bound and wheelchair-bound for the past 2 years after several surgeries, and after 14 sessions on robotic exoskeleton, not only met his goal of standing up, having not done so for two years due to spinal cord injuries, but he also regained enough muscular strength to lighten the burden on his caregiver-wife, a nurse, in now being able to transfer him with just minimal assistance. Gandhi shared with high emotions, “The exoskeleton helped me get back on my feet, regain my confidence and spurred me on to keep crossing milestones with each session, such as reducing the assistance by the device and increasing the number of steps I take.” Gandhi’s wife added, “my husband used to be bed bound and chair-bound for 2 years and doesn’t move out of his room. Now we can get out more often in his wheelchair.”



b) Mr Henry Tan, 66, a retired engineer, has congenital muscle dystrophy and walked with a hunch and a very poor gait pattern with a stick, before suffering a stroke in October last year. After his stroke, he was wheelchair bound, and had completely no strength on his right side. The device helped to address these two conditions he has. Now after 8 sessions, Henry can stand straighter with a better gait pattern than he had for more than 20 years, besides regaining the function in his paralysed limbs. “This over-the-ground device is ‘unforgiving’ and forces me and teaches me to walk properly through its resistance and assistance modes and I can overcome my propensity to fall over by addressing my poor gait patterns which I had not been able to achieve using other methods.” “Henry is now more confident and doesn’t walk with a swing anymore,” added Mrs Tan, the wife.



c)  Madam Salmiah Bte Hadir, 68, suffered a stroke late last year and turned from an able-bodied person who used to 'jalan-jalan' at places, playing with great grandchildren and a capable housewife and homemaker to a wheel-chair bound and 24/7 reliant on external help for mobility. She is still on the therapy sessions and is confident that she can cruise along with just one help and a walking aid, soon.

d)  Ms Teresa Tan Yan Lie, 67, has meningoradiculitis, which is an inflammation of the spinal cord, has been wheelchair-bound for the past 15 years. It was an emotional moment for her after 15 years, she stood up recently on elbow crutches for the first time and today, after several sessions, is reliant on the exoskeleton for only 30%, down from 70% assistance before. A former businesswoman who used to run a family business with her brother, now draws for leisure and has sold her art pieces through the Very Special Arts.

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