Automation, Policy and Patient Needs in Stroke Care, Who Wins?

[1] Department Electronic and Electrical Engineering, University of Leeds, Leeds, United Kingdom

Abstract

For the success of robotic rehabilitation, it is important for the design of robots to not only reflect the needs of the users but also fit into the overall strategy of a body such as the NHS. Currently technology is not utilised to its greatest effect in stroke rehabilitation focusing almost solely on the acute stage where patients are easily accessed and localised in hospital. Care drops off considerable after this phase and attempts to utilise technology to improve this are rare. More focus on the sub-acute and chronic stages are required where robotics may still be applied but focusing on improving the effectiveness of in-home care.

1. Introduction

1.1 Context

Robotic assistance and rehabilitation of stroke survivors has become increasingly attractive as the population gets older. The number of people suffering from stroke has steadily increased along with the aging populations and is the 2nd leading cause of death and 3rd leading cause of years lost due to ill-health worldwide [1]. The largest effects on such illnesses may be made in two ways. The first through preventative measures such as keeping people active, and secondly though effective post stroke treatment [2].

1.2 Aims and Objectives

The purpose of this report is to assess the current medical landscape, the current use of robotic rehabilitation for stroke and assess the effectiveness of the current approach.

2. The Current Medical Landscape

2.1 Patients

The current aim in the UK to stroke rehabilitation is to get patients out of hospital as quickly as possible [3]. Stroke may be split into three phases:

1. *Acute – Up to 10 days where patients will be in hospital.*
2. *Sub-Acute – 10 days to 6 months where patients are at home but still need a lot of care.*
3. *Chronic – 6 months onwards where recovery begins to tail off and may last the rest of the person's life.*

It has been shown that most recovery occurs in the acute stage and correlates with high intensity and consistency of therapy [3] [4]. The NHS recommends that a minimum of 45 minutes with periods of 10 minutes continuous activity daily [5].

With 100,000 new stroke patients per year in the UK there is a large shortage of therapists and their assistants, and the demand on resources is high [6]. The minimum of 45 minutes daily therapy is rarely met [7]. Furthermore, close to 50% of stroke patients do not receive contact from the hospital once they have left, and the burden of responsibility for care and rehabilitation is placed almost solely on family members [6].

2.2 Therapists and Training

Therapy is physically demanding, and physiotherapists are accompanied by up to two assistants to conduct a session for one patient. It takes a minimum of three years to become a physiotherapist with further training to then specialise as a stroke practitioner [7]. Alongside a trained physiotherapist there are physiotherapy assistants who work under their guidance. This takes between 1 and 5 years depending on the level [8]. A large amount of skill and expertise are required for such specialist roles.

Figure 1: Lokomat large departmental rehabilitation machine [9].

3. Cost Effectiveness of Robotic and Conventional Therapy

3.1 In Hospital Treatment (Acute Stage)

In hospital efficiency may be gained if one therapist is able to aid multiple individuals. This has been the focus area for the current set of technology [10].

The evidence suggests that robotic rehabilitation provides no improvement unless combined with functional electrical therapy or virtual reality training [11] [12]. Therefore the main benefit of these methods lies in their potential and cost effectiveness [13] [14]. Few studies of this type have been performed and those that do, focus on the large exercise type machines (figure 1) or wearable exoskeletons only appropriate for hospital departments. The cost effectiveness of exercise type machines is 60% of conventional treatment and for exoskeletons, the cost is triple [14].

3.2 Out of Hospital Treatment (Sub Acute Stage)

Out of the hospital daily care is performed by support workers, and family members. The problem becomes one of personnel again as patients are now decentralised [15] [16]. Unlike in hospital treatment any device must be small, portable, cheap, simple to use and safe for unsupervised or inexpert supervision. Such an approach is currently unfeasible in large part due to cost in the certification process, which is strict, lengthy and expensive for medical devices. Nevertheless, automation also has another benefit which is reduction in the skills required for a workforce. This area has been neglected in the design and approach to the problem. Perhaps a better approach is to focus on the therapist or support worker. The use of exoskeletons in strength augmentation of the carer would allow them to use heavier equipment in the home and reduce the amount of effort required for support of repetitive exercises so increasing their efficiency. Beyond this the integration of apps, teleoperation, and sensors may allow for less skilled personnel to conduct the training. Data may be fed back to experts who can then adapt and direct the assistants allowing for a lower skill set along with remote on the job training.

Figure 2: Rewalk [17](left) bulky full bodyweight support exoskeleton. MAX [18] by SuitX (right) assistive only exoskeleton.

3.3 Pre-Stroke and On-Going Care (Chronic Stage)

Most of the preventative measures for stroke revolve around awareness campaigns, such as anti-smoking, diet and exercise [19]. Again, for those people who have existing mobility issues pre-stroke and in the chronic stage of stroke the use of assistive exoskeleton devices might be appropriate. Such devices are not considered medical devices and do not require the same stringent certification process, this allows for faster and cheaper development times which may be filtered back into medical devices. Beyond cost since they are used for assistance, they do not need to provide full body support, and are smaller and lighter so suitable for home use.

4 Conclusion

The needs of the patients are not being met in the sub-acute and chronic stages and higher gains in the acute may in part be down to the ideal environment of the hospital. Improvement in the later stages is greatly needed and technology might have a huge role to play. A strategy focusing on the sub-acute, chronic and even preventative stages may also be supported by technology specifically in support of carers, and family members so empowering them to provide treatment themselves. Smaller lighter assistive exoskeletons could allow carers to provide care on their own overcoming any physical difficulty. Sensors would allow the monitoring of care remotely and guidance given to both carers and patients quickly and allow for a lower skill set to become a carer or assistant.

References

[1] V. L. Feigin, B. Norrving and G. A. Mensah, "Global Burden of Stroke," *Circulation Research,* vol. 120, no. 3, pp. 439-448, 3 2 2017.

[2] Stroke Association, "A New Era For Stroke," Stroke Association, [Online]. Available: https://www.stroke.org.uk/get-involved/campaigning/new-era-for-stroke. [Accessed 17 February 2020].

[3] C. C. Charalambous, E. E. Helm, K. A. Lau, S. M. Morton and D. S. Reisman, "The feasibility of an acute high-intensity exercise bout to promote locomotor learning after stroke," *Topics in Stroke Rehabilitation,* vol. 25, no. 2, pp. 83-89, 17 2 2018.

[4] E. J. Schneider, N. A. Lannin, L. Ada and J. Schmidt, "Increasing the amount of usual rehabilitation improves activity after stroke: a systematic review," *Journal of Physiotherapy,* vol. 62, no. 4, pp. 182-187, 1 10 2016.

[5] C. S. Clare, "Role of the nurse in stroke rehabilitation," *Nursing standard (Royal College of Nursing (Great Britain) : 1987),* vol. 33, no. 7, pp. 59-66, 1 10 2018.

[6] U. S. Manskow, C. Arntzen, E. Damsgård, M. Braine, S. Sigurdardottir, N. Andelic, C. Røe and A. Anke, "Family members' experience with in-hospital health care after severe traumatic brain injury: A national multicentre study," *BMC Health Services Research,* vol. 18, no. 1, 7 12 2018.

[7] The Stroke Association, "State Of The Nation: Stroke Statistics," The Stroke Association, London, 2018.

[8] NHS, "Physiotherapy assistants/support workers," NHS, [Online]. Available: https://www.healthcareers.nhs.uk/explore-roles/wider-healthcare-team/roles-wider-healthcare-team/clinical-support-staff/physiotherapy-assistantssupport-workers. [Accessed 12 February 2020].

[9] Lokomat Hocoma, [Online]. Available: https://www.hocoma.com/solutions/lokomat/. [Accessed 25 March 2020].

[10] P. Lehoux and D. Grimard, "When robots care: Public deliberations on how technology and humans may support independent living for older adults," *Social Science and Medicine,* vol. 211, pp. 330-337, 1 8 2018.

[11] E. M. Gibbons, A. Nicole Thomson, M. De Noronha and S. Joseph, "Are virtual reality technologies effective in improving lower limb outcomes for patients following stroke – a systematic review with metaanalysis," *Topics in Stroke Rehabilitation,* vol. 23, no. 6, pp. 440-457, 30 5 2016.

[12] D. Baltaduoniene, R. Kubilius, K. Berškiene, L. Vitkus and D. Petruševičiene, "Change of cognitive functions after stroke with rehabilitation systems," *Translational Neuroscience,* vol. 10, no. 1, pp. 118-124, 2019.

[13] S. Hesse, A. Heß, C. Werner C, N. Kabbert and R. Buschfort, "Effect on arm function and cost of robot-assisted group therapy in subacute patients with stroke and a moderately to severely affected arm: A randomized controlled trial," *Clinical Rehabilitation,* vol. 28, no. 7, pp. 637-647, 2014.

[14] G. Carpino, A. Pezzola, M. Urbano and E. Guglielmelli, *Assessing Effectiveness and Costs in Robot-Mediated Lower Limbs Rehabilitation: A Meta-Analysis and State of the Art,* vol. 2018, Hindawi Limited, 2018.

[15] C. Slocum, P. Gerrard, R. Black-Schaffer, R. Goldstein, A. Singhal, M. A. DiVita, C. M. Ryan, J. Mix, M. Purohit, P. Niewczyk, L. Kazis, R. Zafonte and J. C. Schneider, "Functional status predicts acute care readmissions from inpatient rehabilitation in the stroke population," *PLoS ONE,* vol. 10, no. 11, 1 11 2015.

[16] W. Taiwo, A. Wressle and L. Bradley, "Predicting length of stay in specialist neurological rehabilitation," *Disability and Rehabilitation,* vol. 40, no. 5, pp. 548-552, 27 2 2018.

[17] ReWalk Robotics, [Online]. Available: https://rewalk.com/. [Accessed 22 March 2020].

[18] SuitX, "MAX (Modular Agile Exoskeleto)n," [Online]. Available: https://www.suitx.com/max-modular-agile-exoskeleton. [Accessed 22 March 2020].

[19] J. D. Pandian, S. L. Gall, M. P. Kate, G. S. Silva, R. O. Akinyemi, B. I. Ovbiagele, P. M. Lavados, D. B. C. Gandhi and A. G. Thrift, "Stroke 3 Prevention of stroke: a global perspective," 2018.

[20] NHS, "Physiotherapist," NHS, [Online]. Available: https://www.healthcareers.nhs.uk/explore-roles/allied-health-professionals/roles-allied-health-professions/physiotherapist. [Accessed 12 February 2020].

[21] "State of the nation Stroke statistics," 2017.