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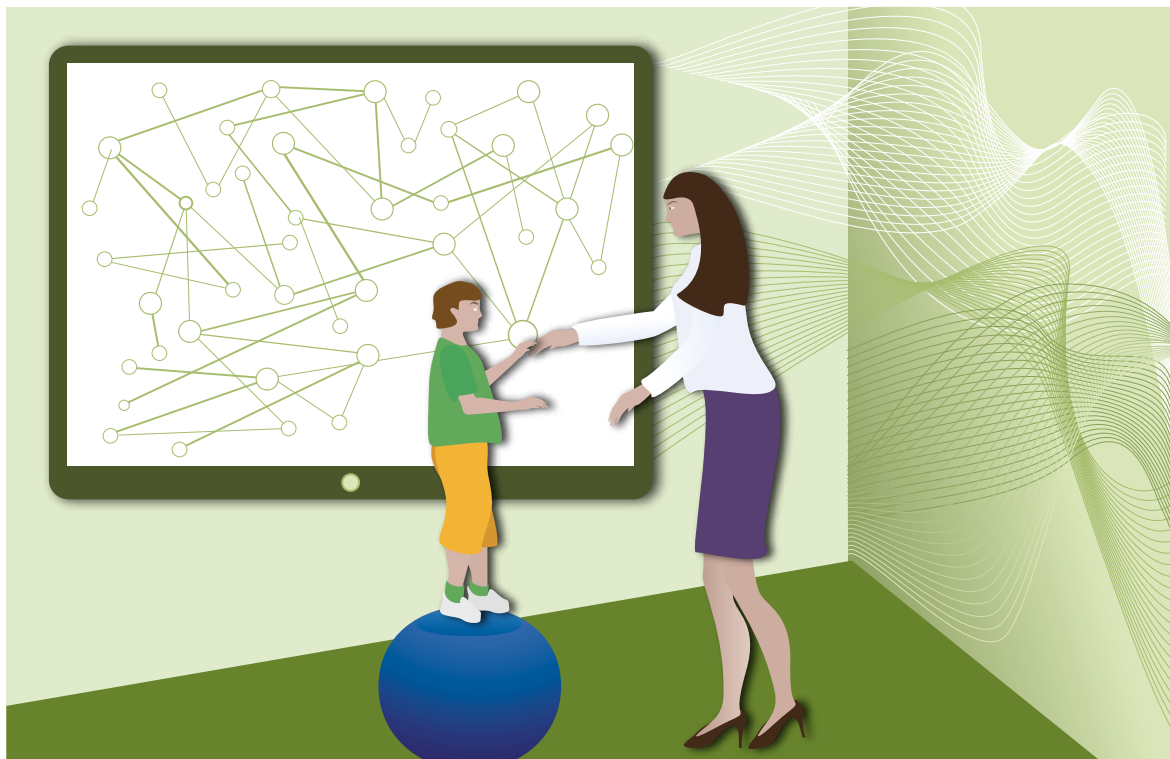
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Innovation in paediatric rehabilitation

A challenge and an opportunity

Review of innovative technologies used at the ALYN Hospital Paediatric and Adolescent Rehabilitation Centre in Jerusalem; past and future technological trends in the field worldwide, including technologies relating to augmented communication, neuro- and movement-sensing, miniaturisation, powered mobility, virtual reality, tele-rehabilitation, 3D gait analysis.



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Rehabilitating children presents special clinical challenges not found in the adult world, but also unique opportunities to use innovative technologies to solve them. This paper reviews the newest rehabilitative technologies being used at the ALYN Hospital Paediatric and Adolescent Rehabilitation Centre in Jerusalem, Israel, as well as past and future technological trends in the field worldwide, including technologies relating to augmented

communication, neuro- and movement-sensing, miniaturisation, powered mobility, virtual reality, tele-rehabilitation and 3D gait analysis. New developments in assistive-technology product design, why the paediatric assistive-technology market is of growing interest for the high tech sector as a whole, and the need for further research to clarify the role of new technologies in paediatric rehabilitation clinical practice, are addressed.

Trying to rehabilitate a child is like trying to hit a moving target. This is because growth and change are the essence of child development. Whereas rehabilitating an adult – for example

after an accident or illness – means returning that adult to their previous level of functioning, paediatric rehabilitation has a far more ambitious goal: to advance a child along the ongoing pathway of

physical, emotional, psychological and social development. For children with disabilities, whether congenital from birth or acquired after illness or trauma, rehabilitation milestones and goals must match the child's chronological age, which, of course, is constantly advancing. Accordingly, we end up aiming for where children should be, rather than where they once were.

Rehabilitating children presents special challenges, but also unique opportunities. The goalposts might be constantly moving, but the young brain is far more agile at learning new tricks than the older adult version. In other words, the plasticity of a child's brain makes it more susceptible to injury (Krägeloh-Mann et al. 2017) but allows children to achieve goals that would be unreachable for adults with the same type of injury (Araki et al. 2017).

“TRYING TO REHABILITATE A CHILD IS LIKE TRYING TO HIT A MOVING TARGET”

Another challenge is that rehabilitation exercises for children must be engaging and fun in order to be effective. Play is a child's work, and conversely, children usually won't work at something challenging unless it is framed and experienced as play. Recasting rehabilitation motor exercises as play, however, has never been easier than in the current era of technology-based entertainment and gaming. Here children have another advantage over adults. Whereas new technologies can be challenging for adults, they appeal to children. Today's children are digital natives who master software-based devices intuitively; in fact, they may be more “abled” in their ability to assimilate new technologies than their adult, digital-immigrant, caregivers.

Embracing innovation and new technologies thus lies at the heart of paediatric rehabilitation today. At our institution we use an eclectic assortment of technologies to help us motivate children and access their inner and external worlds. These techniques include:

- Bedside monitoring of brain activity during rehabilitation therapies, with simplified EEG sensors. This technique helps identify which therapeutic interventions are most beneficial for people who are in a minimally responsive state after traumatic or other brain injury.
- Advanced augmented communication technologies such as eye-tracking devices for operating

digital communication platforms.

- Powered wheelchair mobility for children as young as two years of age and using a wide variety of adaptive switches and levers.
- Virtual reality games utilising VR headsets for physiotherapy and occupational therapy sessions.
- Advanced 3D motion-analysis sensors and software for analysing gait and limb movement in order to develop guidelines for splinting and orthopaedic surgery.

ALYN's innovation center is specifically focused on developing new assistive technologies like these.

The most widespread paediatric rehabilitation technology innovations in recent years have been the development of small, portable devices that can replace the large, cumbersome or non-portable medical systems of the past. The result is that today, technology-dependent children — such as those on chronic respiratory support — can participate in a wide variety of child-appropriate activities that were previously beyond their realm of possibility. At our institution, for example, fully ventilated children with portable ventilators and adapted tubing regularly participate in hydrotherapy sessions in our swimming pool.

One of the most promising innovations in paediatric rehabilitation today is the advent of “remote rehabilitation” via the internet. This is a modality in which gaming and virtual reality technologies may be particularly useful in enhancing compliance with treatment sessions run by therapists at remote locations from the child.

For all new technologies, it is essential to follow up the introduction of the technology with research designed to assess the efficacy and applicability of the new rehabilitation modality as compared to existing methods of care. Unfortunately, the number of new devices is high, and the population of children who use them are small and diverse; as a result, most published reviews of technology use in paediatric rehabilitation are, of necessity, qualitative and descriptive in nature, and lack the quantitative data that would allow for meaningful comparisons with more established protocols. For example, although there is a growing number of reports evaluating remote rehabilitation for adults, to date there are few that focus on children, and none that directly compare the outcomes of paediatric remote rehabilitation programmes with those of in-hospital in-person treatments.

Another ongoing challenge in the world of

paediatric rehabilitation technology is the cost, availability and suitability of assistive devices for those children who need them. Children come in all shapes and sizes, and are constantly growing and developing, both physically and in terms of their participation in educational and leisure activities. This means that the assistive devices they use must be available in a wide variety of sizes, and have to be replaced or rescaled at regular intervals. In contrast, comparable technologies for adults have a far longer shelf-life and can be mass produced in standard sizes, for a larger patient population, and at less cost. To date, therefore, most assistive devices have been designed and produced for adults, and there is a dearth of innovative technologies and affordable devices customised for chil-

“ RECASTING REHABILITATION MOTOR EXERCISES AS PLAY HAS NEVER BEEN EASIER THAN IN THE CURRENT ERA OF TECHNOLOGY-BASED ENTERTAINMENT AND GAMING ”

dren. The upshot is that millions of children around the world are denied access to the assistive technologies that are available to adults in their societies (WHO 2018), even though children potentially have a better chance of overcoming initial injury than do adults. These children are at risk of growing up isolated from society, and may be unable to integrate into educational frameworks and incapable of supporting themselves as adults thereafter.

More recently, however, a paradigm shift has begun in the world of assistive product design. Instead of designing devices for adults and then adapting them for paediatric use, some manufacturers are now designing for paediatric use first, addressing the flexibility and adaptability issues that characterise such designs, and then leveraging those product advantages to the adult market. Similarly, technologies initially designed for children and adults with disabilities, a population for whom mobility, flexibility and ease-of-use are essential design features, have begun to attract the attention of industries for which these features are also important, such as the automotive, sports and mobile device sectors. In fact, some start-ups have intentionally targeted the assistive device sector as

their initial market, and only expanded their focus to general audiences later.

To truly help children with disabilities, however, change and innovation is needed beyond the boundaries of technology. Our societal norms and values need to evolve as well. Instead of distancing people who are noticeably different, we must transition to a model of inclusion in which society as a whole, beyond specialised child development and rehabilitation facilities, relates to people not as “disabled,” but rather (as recently suggested) “differently abled.”

It is incumbent upon us, as health care providers, to look to the future and assure the best possible outcome for these children. This is a labour intensive undertaking, requiring comprehensive and ongoing case management and a high degree of cooperation between multiple caregivers and institutions. Early and intensive investment in innovative childhood development and rehabilitation services will incur a high and immediate price tag, and the return will only be realised years down the road. But every developmental step towards maximal participation in society that a child takes early on helps build a future of lifelong independence and improved wellbeing for that child. This, in turn, will translate into reduced healthcare costs and a healthier and happier lifestyle for us all. ■

KEY POINTS



- ✓ Paediatric rehabilitation offers new opportunities for innovation
- ✓ Paediatric rehabilitation as a field grows with medical advances
- ✓ Societal evolution is needed to improve outcome



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