Enhancing Global Studies with Commercial-Grade Wearable Data

aparito™

Introduction

Wearable devices (wearables) are a rich source of health-related data that can help accelerate study timelines, reduce participant burden, generate novel insights, and make faster, better-informed clinical decisions based on high-quality, real-world evidence.

The data collected by wearables is not limited to basic parameters such as heart rate and physical activity: wearables incorporate advanced sensors that can measure oxygen saturation, electrocardiograms, and even sleep patterns. This comprehensive and continuous monitoring provides research teams with a more holistic view of participants' health, enabling them to uncover novel insights and detect subtle changes that may have gone unnoticed with traditional data collection methods.

In this white paper, we explore our work utilising commercial-grade wearables in global studies, the myriad choices one must navigate to select the right wearable device considering factors such as data accuracy, device compatibility, and participant acceptance, and ask: what's next for wearable devices in clinical trials of the future?

But first...

What are wearable devices?

Wearables can be defined as “sensors and/or software applications on smartphones and tablets that can collect health-related data remotely”[1]. Wearables usually contain sensors, microprocessors, and wireless data transfer. They record real-time data from the patients.

Using wearables can bring numerous benefits to clinicians and patients including real-time data collection, enhancing the quality, quantity and more continuous measuring and provide novel insights on patient-reported outcomes (PROs)[2].

Wearables can increase patient engagement and retention in a study, as they enable autonomy, time and cost savings, and contribute to the creation of novel digital endpoints.

Adopting an end-to-end approach, from selecting the device considering patient preferences, scientific and regulatory aspects, to operational implementation focusing on training, compliance, and patients’ adherence, is key to successful implementation.

How are wearables used in real-world studies?

In the last five years, wearable devices used in clinical trials have seen major development. Moreover, analysts predict that 70% of clinical trials will include a wearable device by 2025[3].

According to clinicaltrials.gov, approximately 1,500 trials are using wearable devices, with over 700 of them successfully completed (update August 2023).

A 10-year review showed the exponential increase in scientific publications from 616 studies on health and wearables in 2000 to over 52,000 in 2022[4].

This projected growth is supported by a proliferation of invasive and non-invasive devices, from smartwatches/activity trackers that measure heart rate and fitness to biosensors-integrated wearables[5]. Those sensors can measure biomarkers (e.g., glucose) using biofluids such as tears, sweat and saliva as illustrated.

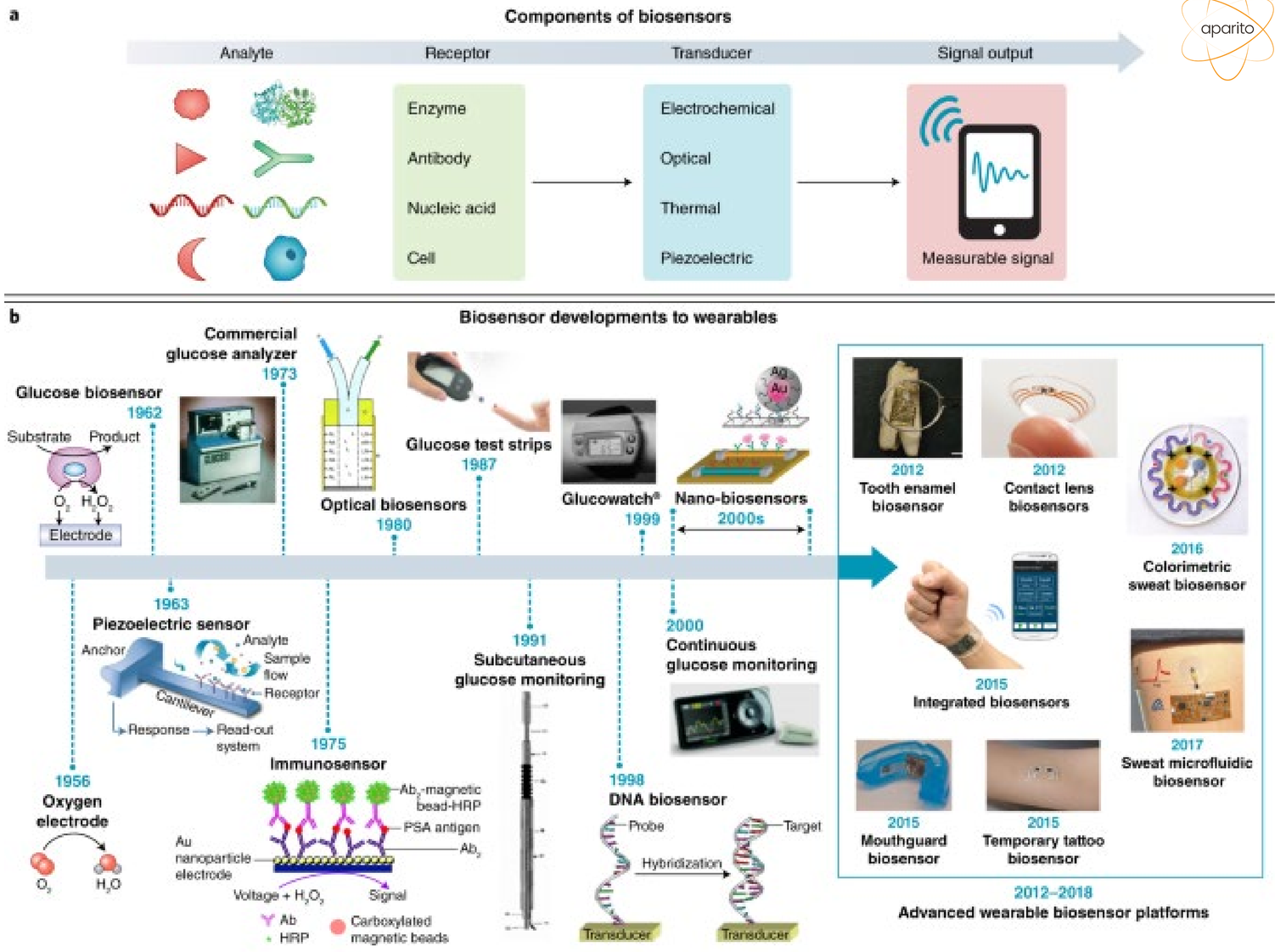

Figure one: Nature Biotechnology Kim, J., Campbell, A.S., de Ávila, B.E.F. et al. Wearable biosensors for healthcare monitoring. Nat Biotechnol 37, 389–406 (2019). https://doi.org/10.1038/s41587-019-0045-y

Such devices, especially commercially available wearables, can transform clinical trials with remote monitoring efficiently and cost-effectively.

Commercial-grade wearables have been used to monitor wearing-off symptoms in Parkinson's Disease patients[6] and have stood up to scrutiny when compared to gold standards in areas such as cardiovascular disease where "smartwatch-derived HRV provides a practical alternative with excellent accuracy compared with ECG-based HRV[7]" to assess short-term variability.

Aparito has gained valuable experience in implementing consumer wearables in global studies and understands the opportunities but also, crucially, the challenges.

Our exploratory work in the use of wearables in physical activity assessment in three paediatric diseases (Niemann-Pick C, Juvenile Idiopathic Arthritis and Duchenne Muscular Dystrophy) concluded that, "Wearable sensor technologies have the potential to provide additional information for our understanding of ambulation in chronic paediatric disease. The wearable devices were easy to use and popular with patients although key features need to be addressed to appropriately meet study objectives[8]".

Here are three examples from our studies that show successes and acknowledge where further work is needed.

Case Study 1: Remote Patient Monitoring for Oncology Patients

The Study

At the onset of the COVID-19 pandemic, Aparito joined a study to provide remote patient monitoring for oncology patients in collaboration with Betsi Cadwaladr University Health Board and NHSx Techforce 19[9].

How wearables factor in

The study sought to demonstrate the feasibility of multidimensional remote monitoring of cancer oupatients in near-real time via the use of the Garmin vívosmart® 4 wearable and the Aparito Atom5™ clinical trial platform to evaluate the quality of the data collected and the insight that can be retrieved from it.

High data capture was achieved via Atom5™ and good data quality allowed for insightful analyses to be performed informing on near real-time patient's health.

The outcome

Over 2,800 patient days were collected via the Aparito Atom5™ app with a median engagement of 73% with 80% of the patients recruited in just two weeks and median engagement with the wearable device was 89%.

Aparito's Atom5™ platform enabled patients taking part in chemotherapy to report their health status via a user-friendly interface in near real-time and provided hospital staff with the data to monitor patients at home.

Disclaimer: This is a consumer-grade wearable device, not a medical device, and cannot be used for treatment or disease diagnostics.

Case Study 2: Accelerometer - Derived Sleep Measures in Idiopathic Dystonia

The Study

In Investigation of reported sleep disturbance in individuals diagnosed with cervical dystonia[10], our primary objective was to identify sleep disturbances by comparing accelerometer-determined sleep variables between the cohorts.

We recruited 50 individuals diagnosed with dystonia and 47 age- and sex-matched unaffected controls.

How wearables factor in

Individuals wore a Garmin vívosmart® 4 continuously over seven days on their non-dominant wrist, while completing PROs via the Atom5™ app to report on sleep quality measures. These include the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleeping Scale (ESS), the Dystonia Non-Motor Symptoms Questionnaire (DNMSQuest), a 7-day sleeping diary, and a daily visual analogue scale (VAS) to assess sleep, anxiety, pain and quality of life.

The outcome

Dystonia participants had poorer self-reported sleep patterns compared to controls: accelerometery measurements demonstrated later sleep times, reduced time in bed, and shifts in circadian rhythm.

The study showed the feasibility of using wearable devices in estimating sleep measures and architecture and emphasised the need for clinicians to screen for sleep disturbances as part of routine clinical assessments. We also identified that monitoring of sleep may be important for the prevention and management of non-motor symptoms.

Case Study 3: Precision Medicine in Epilepsy in South Africa

The Study

Aparito and Red Cross War Memorial Children's Hospital (RCWMCH) launched the Precision Management of Epilepsy study where mHealth technologies were combined with genetic and pharmacogenomic analysis to improve the treatment outcomes of children with refractory epilepsy in Cape Town, South Africa[11].

How wearables factor in

Physical activity, sleep, and heart rate were continuously monitored with a wearable device for six months. Caregivers completed regular ePROs and reported seizures and ad hoc events using the Atom5™ app.

The outcome

The mHealth technology was able to capture important information that gives an impression of the overall experience of the children and their caregivers. Thirty-seven participants (94.9%) reported at least one clinical event. Seventy-nine percent of caregivers reported seizure events in their children, which were the primary event anticipated. Median engagement with the wearable device and monthly mPROs was 30.8% and 57.1%, respectively. However, most participants (87%) had to be given smartphones for them to have Bluetooth capabilities and access to the study app.

Patient-centric healthcare technology designs are needed as emphasised by the caregivers who were impacted by socioeconomic dilemmas which include: clinical literacy, digital health literacy/digital literacy, crime and internet access.

How do I select a wearable device?

Before a wearable device is added to a clinical study, there are criteria that need to be examined to ensure that the device fulfils all requirements.

What parameters need to be measured?
Wearable devices can measure various parameters: sleep, heart rate and heart variability, mobility, biomarkers, etc. This will determine the kind of wearable to select for the patient (e.g., contact lens measuring glucose levels vs smartwatch collecting data about heart rate and mobility).

Which clinical area it is intended for?
Based on the literature, wearable devices have been used mainly in respiratory, cardiology, oncology, immunology, rheumatology and rare diseases, where wearables facilitate recruitment and the participation of patients due to the low number of patients and difficulties in travelling to clinical sites.

This list should not be limited providing that the wearable is adapted for the clinical study.

What kind of measurement is sought?
Scientific publications report that wearable devices can be potentially integrated into any kind of clinical design, whether it is for an observational or an interventional study, for diagnosis purposes or for prevention (e.g falls), remote management (e.g during the COVID-19 pandemic, monitoring of cancer patients) or to use the device as a means to create novel digital endpoints and contribute to clinical design improvement (e.g., Aparito and Garmin's work to digitise the 6-Minute Walk Test).

Aparito Device Selection Criteria

When considering a wearable device we examine three areas to ensure all needs are met:

The Patient: Usability, Form Factor, Compliance

Our device selection process is a patient-centred approach. We make sure that the device will be tolerated and accepted by the study population either by exploring scientific evidence or conducting usability testing. The device characteristics such as form, size, convenience to wear, battery life and impact on the patients' daily life activities is considered carefully to ensure acceptability by the patients and minimise burden. Device acceptability by the study participants is critical to maintain compliance throughout the study.

Device Type: Classification, Data Acquisition and Transfer

The context of use defines the medical-grade classification requirement for a study. Consumer-grade devices may be the most suitable option for exploratory studies, while if they are used to develop primary or secondary endpoints, medical-grade devices are required. Understanding its performance and accuracy characteristics is necessary for deciding if a device is fit for purpose and can measure what is needed (e.g. sensors sensitive enough to pick up tremors). The raw data availability is also considered carefully, as often only processed and summary data are available and data processing algorithms are not disclosed. The data acquisition and its impact on data transfer and patient's user experience is considered. Massive data can present challenges in the acquisition, transfer, and processing of data.

Regulators: Scientific Validity and Evidence

Scientific validity of the device for the context of use is evaluated when selecting a device. Scientific evidence or validation studies are supplied to the relevant regulatory bodies to support the decision of the selected device and get the study approved.

Ensuring patient compliance, adherence and engagement

To ensure patient compliance, adherence and engagement the device should be:

1. Self-fitting, allowing the patient to set up, configure and operate without the aid of a physician.

2. Passive, doing most of its data collection silently in the background with little to no intervention by the patient or physician to generate reports, alerts, or user value.

3. Effective, providing clinically valuable data that can be accessed and absorbed quickly by a physician and downloaded and transferred easily by a non-technically fluent patient.

4. Durable, with a battery life long enough to limit patient interventions.

5. Aesthetically pleasing and not look like a “medical appliance” - consumer devices do not stigmatise.

6. Able to offer patients a view of their own data.

Once a wearable device has been preliminarily selected, we can guide you through additional considerations and challenges before a final decision is made.

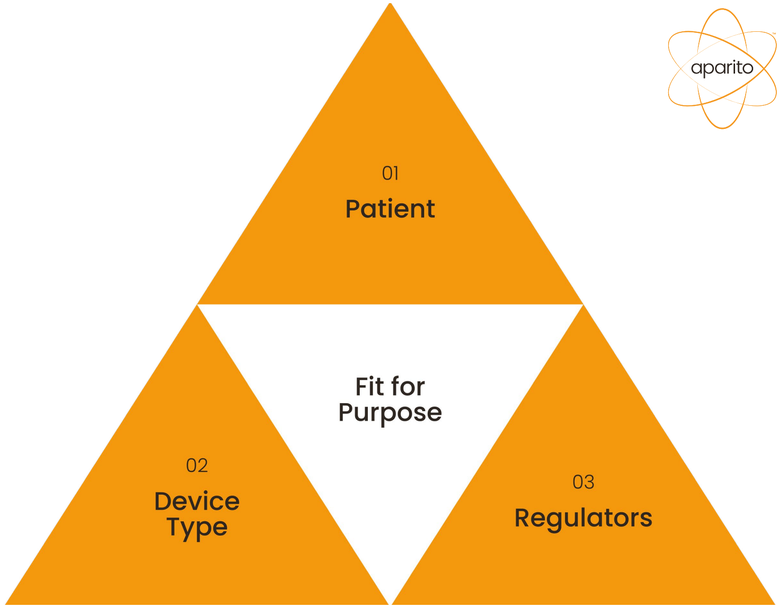

Figure three: Aparito considerations for wearable device selection

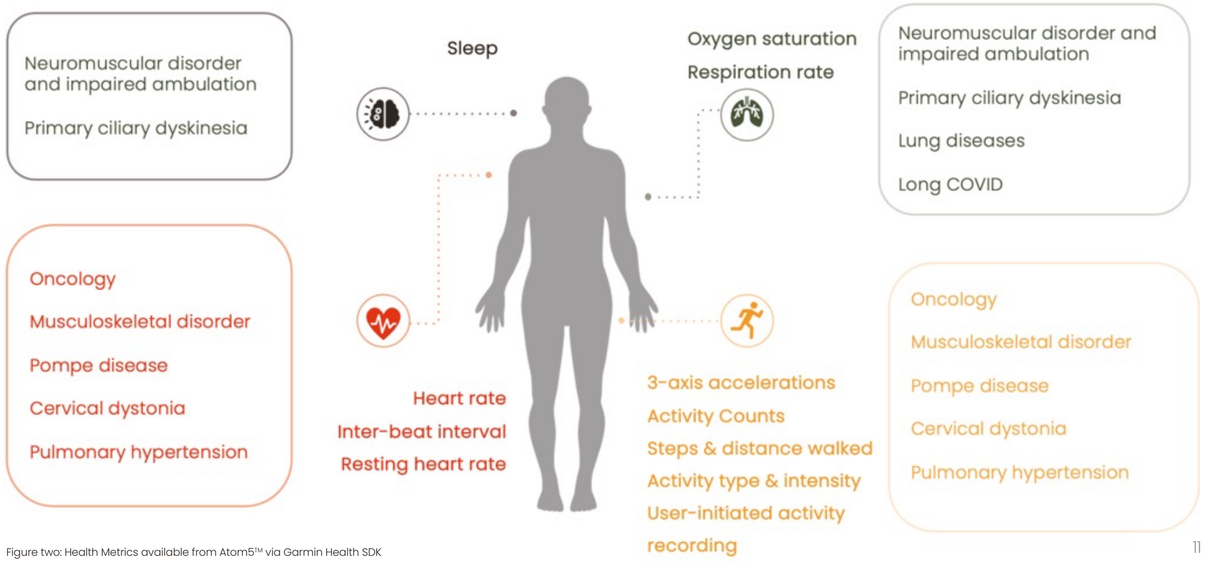

Figure two: Health Metrics available from Atom5™ via Garmin Health SDK

What's next?

Over the coming years we expect to see five key trends in clinical trial wearable devices;

1. Higher adoption rate of consumer grade wearables in clinical studies with other health-related parameters such as sleep, stress, and fatigue becoming more important than just steps, activity, exercise, etc.

2. More members of the general population actively donating their data for studies, i.e. citizen scientists.

3. Heart Rate Variability[12] and enhanced capabilities to provide more meaningful cardiovascular insights.

4. Blinding of participants using commercial grade wearables.

5. Increased uptake of novel digital biomarkers as regulatory bodies encourages the adoption of validated endpoints that capture high-quality data.

What's the greatest challenge that stands in front of this opportunity? Keeping patients engaged with their wearables to ensure that sponsors receive the data they need. Whilst device characteristics, increased capabilities and regulatory approval are crucial to driving further adoption, even the most qualified wearables in the world are useless if they are not used consistently and properly by patients.

With over 3000 patients enrolled in studies using wearables across two dozen countries spanning EMEA, AMER and APAC, it's a challenge that Aparito understands and we're here to drive this opportunity forwards for the benefit of patients, sponsors and clinicians.

The future is about integrating these devices into users' lives in meaningful ways. Imagine a future where your wearable not only tells you your current health stats but can also anticipate potential health concerns. They won't just track health; they could predict, guide, and, in conjunction with healthcare professionals, provide a roadmap for a healthier life.

Supporting Global Wearable Studies with Atom5™

Aparito's patient-generated data platform is disease-agnostic and scalable, ready for rapid deployment in global studies to support wearable device data capture in 193 countries and 125 languages.

Designed and built by regulators and clinicians, Atom5™ is 21 CFR Part 11, GDPR and HIPPA compliant by design and enables clinical trials to be conducted via disease-specific smartphone apps, integrating video assessments and wearable devices via the Garmin Health SDK.

References

1. Izmailova ES, Wagner JA, Perakslis ED. Wearable Devices in Clinical Trials: Hype and Hypothesis. Clin Pharmacol Ther. 2018 Jul;104(1):42-52. doi: 10.1002/cpt.966. Epub 2018 Apr 2. PMID: 29205294; PMCID: PMC6032822.

2. Sarwar Beg, Mayank Handa, Rahul Shukla, Mahfoozur Rahman, Waleed H. Almalki, Obaid Afzal, Abdulmalik Saleh Alfawaz Altamimi, Wearable smart devices in cancer diagnosis and remote clinical trial monitoring: Transforming the healthcare applications,Drug Discovery Today, Volume 27, Issue 10,2022,103314,ISSN 1359 6446,https://doi.org/10.1016/j.drudis.2022.06.014.

3. Clinical leader 2020: Jansen, Y., & Thornton, G. (2020, February 25). Wearables & Big Data In Clinical Trials — Where Do We Stand? Clinical Leader. https://www.clinicalleader.com/doc/wearables-big-data-in-clinical-trials-where-do-we-stand-0001

4. Escobar-Linero E, Muñoz-Saavedra L, Luna-Perejón F, Sevillano JL, Domínguez-Morales M. Wearable Health Devices for Diagnosis Support: Evolution and Future Tendencies. Sensors (Basel). 2023 Feb 3;23(3):1678. doi: 10.3390/s23031678. PMID: 36772718; PMCID: PMC9920884.

5. Kim, J., Campbell, A.S., de Ávila, B.EF. et al. Wearable biosensors for healthcare monitoring. Nat Biotechnol 37, 389–406 (2019). https://doi.org/10.1038/s41587-019-0045-y

6. Victorino JN, Shibata Y, Inoue S, Shibata T, Understanding Wearing-Off Symptoms in Parkinson's Disease Patients using Wrist-Worn Fitness Tracker and a Smartphone, Procedia Computer Science. Volume 196 2022 Pages 684-691. ISSN 1877-0509. https://doi.org/10.1016/j.procs.2021.12.064.

7. Theurl F, Schreinlechner M, Sappler N, Toifl M, Dolejsi T, Hofer F, Massmann C, Steinbring C, Komarek S, Mölgg K, Dejakum B, Böhme C, Kirchmair R, Reinstadler S, Bauer A, Smartwatch-derived heart rate variability: a head-to-head comparison with the gold standard in cardiovascular disease, European Heart Journal - Digital Health, Volume 4, Issue 3, May 2023, Pages 155–164, https://doi.org/10.1093/ehjdh/ztad022

8. McErlane F, Davies EH, Ollivier C, Mayhew A, Anyanwu O, Harbottle V, Donald A. Wearable Technologies for Children with Chronic Illnesses: An Exploratory Approach. Ther Innov Regul Sci. 2021 Jul;55(4):799-806. doi: 10.1007/s43441-021-00278-9. Epub 2021 Apr 12. PMID: 33844190.

9. Komarzynski S, Wreglesworth NI, Griffiths D, Pecchia L, Subbe CP, Hughes SF, Davies EH, Innominato PF. Embracing Change: Learnings From Implementing Multidimensional Digital Remote Monitoring in Oncology Patients at a District General Hospital During the COVID-19 Pandemic. JCO Clin Cancer Inform. 2021 Feb;5:216-220. doi: 10.1200/CCI.20.00136. PMID: 33606562.

10. Bailey GA, Matthews C, Szewczyk-Krolikowski K, Moore P, Komarzynski S, Davies EH, Peall KJ. Use of remote monitoring and integrated platform for the evaluation of sleep quality in adult-onset idiopathic cervical dystonia. J Neurol. 2023 Mar;270(3):1759-1769. doi: 10.1007/s00415-022-11490-4. Epub 2022 Nov 21. PMID: 36414751; PMCID: PMC9971061.

11. Davies EH, Fieggen K, Wilmshurst J, Anyanwu O, Burman RJ, Komarzynski S. Demonstrating the feasibility of digital health to support pediatric patients in South Africa. Epilepsia Open. 2021 Dec;6(4):653-662. doi: 10.1002/epi4.12527. Epub 2021 Sep 2. PMID: 34310860; PMCID: PMC8633462

12. 4 reasons why HRV (heart rate variability) is the health metric of the future 2023, National University of Health Sciences website, Australian government, accessed 23 October 2023, https://www.nuhs.edu/4-reasons-why-hrv-heart-rate-variability-is-the-health-metric-of-the-future/

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