SVOA Neurology

ISSN:2753-9180

Short Communication

Digitisation of Neurology

Partha S Ray *

Affiliation:

NHS England, The Walton Centre Liverpool and Liverpool University, United Kingdom

***Corresponding Author:** Prof. Dr.* Partha S Ray, *NHS England, The Walton Centre Liverpool and Liverpool University, United Kingdom*

***Received:** February 14, 2021* ***Published:** February 28, 2021*

We have been living in a progressively technologically rich environment for the last decade or two. This has impacted greatly our social lives, in addition to the usual applications of digitisation that we have now taken for granted in our day-to-day lives, for example, in banking, travel and e-commerce. Medical specialties being rather traditional historically relying on traditional methods of working and the face-to-face century-old doctor-patient interactive paradigms have lagged behind in the application of technological advancements in the day-to-day rollout and integration of these technologies in daily work on the patient interface. In the last decade or two researchers in the medical specialties painstakingly have been developing algorithms, gadgets, applications, robotics and so many other avenues to modernise the practice of medicine. The convenience of these was not wholly appreciated prior to the COVID-19 times globally when the utility of all these advantages of digitisation was suddenly brought to the forefront in real life across the globe and the advantages of the "new ways" of working in clinical practice and in research became obvious to traditionalists. The digitisation of neurology is a part of the spectrum that is bound to occur across the interface of all medical specialties going forward. The development of personalised medicine ("holy grail") would be the cherished outcome hopefully.

The vast data generated in everyday neurology practice relies on digitisation of the healthcare data using algorithms, artificial intelligence and cloud computing to derive useful information for healthcare organisation and improvement of treatment modalities. Biosensors tracking functions of the nervous system provide a real continuous data acquisition option instead of the periodic clinic assessments that now appear suboptimal with the technology available for real-time synchronous assessments and intervention opportunities. Neuro rehabilitation utilises neural prosthetics and neuro robots integrated into rehabilitation exoskeletons and artificial limbs. The principles of brain computer interface using artificial intelligence driven algorithms for computation of biological neural networks to simulate the functions of lost nerve tissue have developed significantly in the labs. Research and clinical trials could use potential biomarkers acquired digitally on a continuous basis to improve the finesse of the acquisition of data to eliminate blind spots in the observational analysis of niche clinical neuroscience research interventions and projects.

Artificial intelligence, machine learning, deep learning, computational models of biological neural networks and their integration in robotics and prosthesis utilising continuous learning algorithms based on "big data" and cloud-based platforms has already impacted clinical practice in accurate interpretation of neuro imaging, for health care systems to identify bottlenecks in workflow and reduce medical errors and primarily for patients who are now able to record their health data continuously real-time and transmit the same to healthcare monitors which are increasingly nonhuman. The brain computer interface models developed over last many decades has now reached the functionality of biological applicability and relevance. Close connections between the human brain and intricate gadgets with sensory and motor feedback loops and increasingly cognitive robotics linked to the brain will be real-life solutions in the day-to-day rehabilitation of patients. Animal models to develop these intricate interfaces will lead to better therapies as we understand the central nervous system functioning better.

"The complexity of the human brain is difficult to simulate" – would be the understatement of human civilisation. The efficient energy system human brain is to undertake the vast amount of computing it does for all of us at all times is mind-boggling. This significant gap between the energy utilisation and the efficiency of the computational systems developed with deep neural networks for several complex cognitive tasks is gradually making headway in this energy conservation process in addition to computers being able to undertake 200 quadrillion actions simultaneously using low-energy expenditure. These supercomputers using spiking neural networks are the third generation of artificial neuronal models that simulate the key time-based information encoding and processing aspects of the brain.

The cerebellum, basal ganglia structures and the neuronal networks connecting the frontal – parietal – occipital and temporal regions at multiple levels through association fibres and the various different neuronal networks which we have defined as working models of the human brain to explain not only our higher cognitive functions but also the motor control requires immense amount of computing power. The supercomputers – spiking neural network architecture – SpiNNaker developed by University of Manchester as part of the European Union human brain Project to develop artificial brain systems can only approach 1% of the human brain's capability. We have a long way to go!

Clinical applications in neurology

In the traditional neurologist-patient interaction a historical analysis of clinical phenomena in a subjective descriptive mode has been the conventional practice. While trying to ascertain the significance and magnitude of neurological phenomena driving the symptoms using this mode it is obvious that this practice is suboptimal in the current technology rich environment. With mobile devices and wearables patient monitoring is undertaken continuously outside of the hospital environment. Mapping social, behavioural and cognitive biomarkers using data from personal digital devices and next analysing them is part of the "digital phenotyping" concept.

Drug-drug interactions, prescription errors, drug compliance, drug side effects monitoring and drug histories and drug allergies at a time when there has been a phenomenal growth of prescriptions requires urgent digitisation to avoid serious adverse side effects particularly of large numbers of newly licensed drugs that are preventable with digitisation. Pharmacological research in the development of new molecules or repurposing existing molecules using digital biomarkers is already in practice. Conventional reliance on clinical rating scales and subjective measures of function to assess the clinical effectiveness of a compound is replaced by digital biomarkers providing accurate synchronous real-time input of the assessment variables onto a platform- these can be then synchronously analysed. In multiple sclerosis, depression, Parkinson's disease and epilepsy these technologies and applications are already being tested and validated for research utilisation and clinical trial design. In addition to enriching the quality of the data obtained the technical innovations reduce face-to-face clinical contacts (a real threat in the post COVID-19 times), reduce costs of clinical trials and capture real-world patient behaviour and compliance, otherwise not possible to test so far. In an era of phase 4 post marketing surveillance of side effects, efficacy and compliance issues among many others digital technology will necessarily come to the forefront.

Electronic health records have gradually penetrated all practices in the industrialised world for the last 20 years. This has improved healthcare delivery and record keeping, avoided adverse intervention and drug side effects, potentially facilitated clinical trials and given patients the ownership of their health care records in an efficient format. Integration of picture archiving and communication systems into the electronic health records accessible by both the physician and if need be by the patient have only become possible through digitisation. The benefits of this is already being appreciated as Tele neurology has leapt to the forefront in the COVID-19 times as a solution to provide seamless neurological services to patients while ensuring safety to both the clinician and the patient from infection hazards.

Through tele-neurology that is heavily reliant on digitisation, patient physician electronic communications have become the new norm. Utilisation of portals for videos for both synchronous and asynchronous consultations, transmission of pictures and data/images from neuroradiology, neurophysiology and neuro pathology and assessment of various signs and symptoms on the digital platform are the benefits of digitisation process.

The digitisation in specific chronic neurological disorders and its practice

1) Epilepsy: smartwatches having seizure detection applications using electrodermal activity as well as accelerometery detects generalised tonic chronic seizures with negligible false alarms. Through real-time alerts of seizure episodes patients can have electronic platforms to provide expert assessment and management interventions to improve outcomes.
2) Alzheimer's disease: cognitive functioning, behaviour profile, social engagement, adherence to medications can all be tracked through sensors as part of continuous in-home monitoring. This replaces or adjuncts episodic physician visits to improve quality of patient care. In addition to clinical care, research opportunities with potential new molecules are facilitated to detect small variables in research trial protocols to detect changes at an earlier stage of the disease pathology.
3) Parkinson's disease: in addition to kinematic data obtained from specialised gait laboratories, wearable inertial measurement sensors attached to shoes or watches enable tracking of gait and arm swing changes in Parkinson's disease and detection of falls/near falls. These accelerometers nowadays routinely incorporated in smart phone applications help real-time continuous information of postural gait instability which far outweighs periodic patient assessment through clinic visits.

4) Multiple sclerosis: most drug companies manufacturing disease modifying drugs for MS have adherence measurement digital tools. Through significant issues of non-compliance affecting the response to therapy these electronic autoinjectors help to seamlessly monitor adherence to cloud-based platforms. Other devices monitoring balance and stability via coupled shoe insole and vest monitoring systems have progressed balance and gait training for MS patients.
5) Sleep disorders: polysomnography results often conflict with subjective self-reporting of sleep and therefore monitoring sleep longitudinally proves to be a challenge. Wearable sensors in form of smart watches and blood flow detectors attached to fingers help to identify variations in the phases of sleep.
6) Diabetic retinopathy: in April 2018 the US FDA granted approval to an AI-based device to detect diabetic retinopathy. This device after performing a screening test generates a report through an AI cloud-based platform without any clinician involvement and an onward referral to an eye specialist for further treatment. This smart phone-based fundus camera alternative is in field use in remote parts of India where ophthalmologists are not on ground and the images taken by healthcare worker without mydriatic use are transferred to a central base for interpretation and specialist ophthalmological care where necessary.
7) Neuro rehabilitation: already discussed brain computer interface technology for robotics and neuro prosthetics have revolutionised the care of paraplegic patients with use of exoskeleton for gait retraining. The control of prosthetic limbs through motor loop feedback is already in operation.
8) Robotic neurosurgery: remote surgery on the brain and spinal cord using robotics often undertaken through telesurgery modality is already evolving. In addition to improving upon human physiological deficiencies of hand tremor, speed of movement, fatigue and range of movement and precision, various AI-based solutions combined with surgical robotics and image guidance facilitates accurate interventions with lessened human errors. Machine learning enables computers to make accurate predictions about outcome from previous data of neurosurgical procedures undertaken by the surgeon.
9) Psychiatry: although supercomputers are way behind in cognitive skills and emotional intelligence/human interaction assessments, AI can analyse data and recognise patterns too subtle to be noticed by human. On a more common platform patients could alert mental health specialists of any crisis situations efficiently through alerting devices. Assessment of anxiety attacks and fluctuations of mood states can be assessed through its impact on the autonomic nervous system characterised by heart rate variability and skin conductance measurements that are part of the routine autonomic nervous system diagnostic workup presently.

Regulation of digitisation in neurology

A myriad of new, innovative and alternative approaches to the patient/healthcare system interface has brought to light ethical, legal and regulatory challenges. In addition to platform security, patient confidentiality and liability of the digital technology there are issues as well as those of standardisation. Both international and national regulatory frameworks have been drafted. The devices have issues of patent and standardisation and security issues prior to licensing.

The future:

Digitisation is here to stay. As in other sectors digitisation of medicine and in neurology will prove to be a boon when we translate the progress made so far to everyday clinical practice and research opportunities. The applications appear to be limitless and will evolve as the computing power and efficiency increases and brain computer interface and deep learning makes progress. On the clinical front moving on from simple biosensing wearables and analysis of clinical data to integration of diagnosis and therapeutics there will emerge prediction models based on statistical analysis of "big data". They will also be advancement of research in neurological disorders as alluded to. All this will depend on a close collaboration between program developers, neuro scientists and engineers, statisticians and most importantly patient partners for whose benefit all this is being geared to for the eventual benefit of society and medicine from within neurology.

Citation: Partha S Ray. "Digitisation of Neurology". SVOA Neurology 2:1(2021) Pages 41-43.