Commentary

International Classification of Functioning, Disability, and Health augmented by telemedicine and artificial intelligence for assessment of functional disability

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Abstract

The concept of functional disability is aligned with the biopsycho-social model of disability. However, there are reasons why the antiquated measurement of medical impairment continues to be in use. We propose solutions for a fairer process using the International Classification of Functioning, Disability, and Health (ICF) at the level of the medical boards augmented by telemedicine and artificial intelligence (AI). The proposed technologies (Level 1 and Level 2 AI) need to be tried in pilot projects. It will accomplish two goals, the first being the measurement of disability and not merely the impairment. Second, and perhaps more importantly, making the process more transparent in creating a "just" society.

Keywords: Artificial intelligence, International Classification of Functioning, Disability and Health, Persons with Disability, telemedicine

Introduction

The "Preamble to the Convention on the Rights of Persons with Disabilities and Optional Protocol United Nations" considers disability as a consequence of the interaction between the impairments and factors such as environmental and personal.[1] A conventional disability evaluation is in line mainly with the medical model of disability. It states the percentage of permanent physical impairment (PPI) and does not accurately depict the individual's functioning. This apparent flaw lies in the fact that a PPI calculation does not consider the relevant environmental and personal factors, as elaborately mentioned in the International Classification of Functioning Disability and Health (ICF). Recent research on disability highlights how barriers, such as environmental and personal, have a significant impact on disability.[2-4] In instances where the matter is under judicial consideration, such as compensation due to an accident, the awarded sum is based on functional disability (FD).[5]

ICF by the World Health Organization (WHO) can be a useful tool that can combine the physical impairments with environmental and functional factors to close the gap between the medical and social models by using core sets and evaluating FD. However, its use will need augmentation by technology, given certain shortcomings. The use of ICF entails a lot of options where subjectivity can creep in. Besides, the measurement of environmental and personal factors is resource-consuming. The need of the hour is to embrace technology, such as telemedicine and artificial intelligence (AI), to make life easier for all the

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stakeholders, such as the medical professionals, the judiciary, and persons with disability. This article intends to be informative regarding ICF's use augmented by telemedicine and AI in the evaluation of FD and its anticipated benefits in addressing the existing workflow problems.

Existing workflow and the need for reforms

The person requiring a disability assessment presents to a designated medical board. After evaluation and examination, the committee awards a PPI based on the prevailing guidelines. This evaluation does not take into account the personal and environmental factors affecting the applicant's daily life. Instances of disability assessment by doctors to benefit the claimant are rampant. On the other hand, mistakes due to human error are also commonplace. The calculation of FD is restricted to the domain where compensation is involved. The judicial tribunal invariably asks for evidence to arrive at FD's level in cases where compensation is involved.[5] Other benefits are still accorded based on the percentage of impairment arrived at by medical boards.

Artificial intelligence

AI refers to the use of computer technology to simulate intelligent behavior and critical thinking comparable to humans. AI programs have conquered chess; however, fully automated disability evaluation may require some more time.[6] It will require the requisite hardware of various dimensions to accommodate the diversity that exists amongst human beings.

The concept of a functioning profile

Filling up the ICF creates a profile similar as depicted in [Figure 1]. This profile is a hypothetical one with only one parameter chosen to simplify the concept. It explains how ICF helps to arrive at an FD level. It covers most domains in routine life; however, it leaves the rating to the person evaluating the disability. There needs to be a consensus amongst various members amongst the authorities evaluating disability regarding how we would grade different ICF domains. Training data for AI requires agreement on how grading of parameters will happen, irrespective of the location. AI can objectively replicate the same.

The suggested workflow

The suggested workflow is that the person is supposed to apply for the certificate on the website, which will first ascertain whether a benchmark disability exists or not. A smart assistant along with a video analysis will help in making this decision. A webcam will be set-up with pre-specified questions and a pre-specified protocol with instructions. Video guides and instruction manuals provided to evaluate disability will help to conclude with adequate confidence whether the patient has a benchmark disability or not. An appellate authority will take care of any appeals. In case it does qualify as a benchmark disability, AI fills WHO's ICF core set to create a functioning profile; uses telemedicine to measure capacity and performance, which may depend on the environment and the societal norms existing; assign weights to various parameters to arrive at a percentage. Supercomputers will collate the data and issue an accurate depiction of FD after giving appropriate weights to the functioning profile generated.

This workflow can be adopted in compensations, and other spheres such as disability pensions, reservations in educational institutions, reservations in government jobs, etcetera [Figures 2 and 3].

Functioning Profile

ACTIVITIES AND PARTICIPATION		Difficulty				
		0	1	2	3	4
d450	Walking (G)	P				
		C				
ENVIRONMENTAL FACTORS		Facilitator			Barrier	
		+4	+3	+2	+1	0	1	2	3	4
e355	Health professionals									

P refers to performance
C refers to capacity

Figure 1: A hypothetical functioning profile of a person with spinal cord injury. This profile of functioning was built while using the ICF-based documentation form on this web page https://icf-core-sets.org/es/page0.php courtesy ICF Research Branch

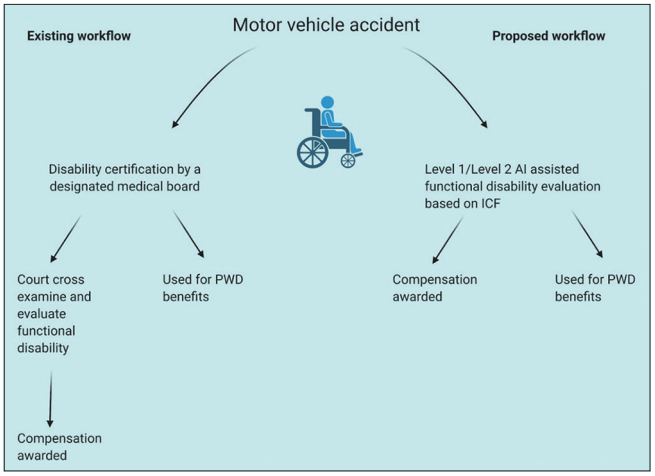

Figure 2: Workflow: Existing and proposed

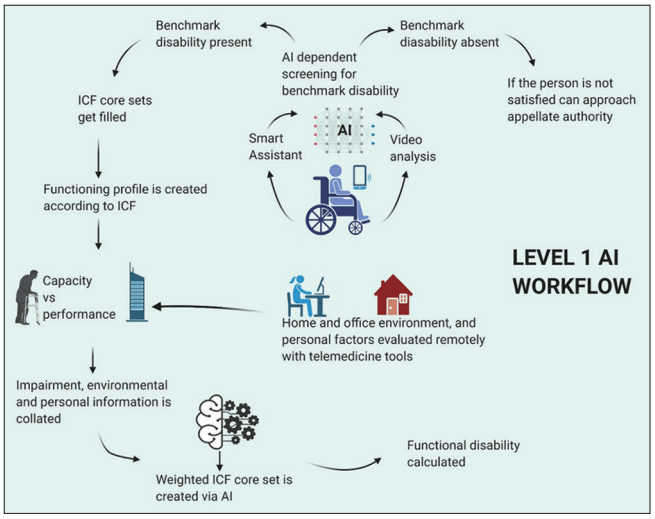

Figure 3: Level 1 AI workflow

There can be three lower limb amputees with the same degree of PPI but with different FD as per the existing workflow. The reason could be as simple as age and vocation. The proposed system will consider many environmental and personal factors with weights ascribed to each based on the AI algorithm to arrive at an accurate functional level.

Existing tools, software and hardware

AI and machine learning (ML) are encompassing every sphere of life. The requirement of complicated hardware at the point of contact (edge of the system) is minimized while the cloud is bearing a significant workload. After being released in 2010, the Microsoft Kinect™ has become a research interest as an affordable, miniaturized, and easy to use tool for markerless motion tracking. It has been used in several musculoskeletal and neurological conditions such as Parkinson's disease, spinal cord injury, stroke, limited shoulder range of motion to evaluate physical impairment.[7-15] Tools such as Lokomat™ and ReWalk™ are exoskeletons that have been used for motor evaluation for lower limb with success.[16] Other categories of impairments like speech and language, vision, hearing, cognitive and mental retardation are relatively easy to be processed by AI systems. High-fidelity microphones, headsets, and online questionnaires are the only required hardware at the edge, and these are readily available. Multiple studies have shown encouraging findings.[17] Aira™ is a technology used for the assessment of vision as well as rehabilitation.[18] ML, deep learning (DL), and natural language processing (NLP) are being used for cognitive and mental impairments.[19] Audiology is using advanced technology already for assessment and rehabilitation.[20,21]

Level 2 AI workflow

Examination is done by the doctors in Level 1 AI, even though it may be through telemedicine. However, the objective is to automate disability evaluation in Level 2 AI entirely. It will need exoskeletons, robots, motion trackers, and the latest hardware and the technology used in Level 1 AI. The benefits of a disability analyzer are numerous, starting from a straightforward application system, accessibility to the closest disability analyzer, reproducibility of results throughout the country as the machines would be the same, and linkage of all disability analyzers [Figure 4].

Training data

Any AI system will require an adequate representation of the various types and degrees of disability. The process will require training until it starts matching and eventually doing better than medical boards requiring human beings. Three phases are involved in the actual process of AI teaching itself: training, validating, and checking. By feeding data into the computer system, it is trained to generate a specific prediction with each loop.

What is essential is that the training data be free of bias, and this can happen when people training these models; keep this in mind as the model will work in a biased manner if not trained without a partial data set. The model will reproduce that behavior trained on data that has a bias in it. AI-based decision-making approaches have started being used in situations where experts often disagree.[22] Disability evaluation is undoubtedly one category where experts often disagree. Regulatory issues, economics, and liability also need to keep in mind.[23]

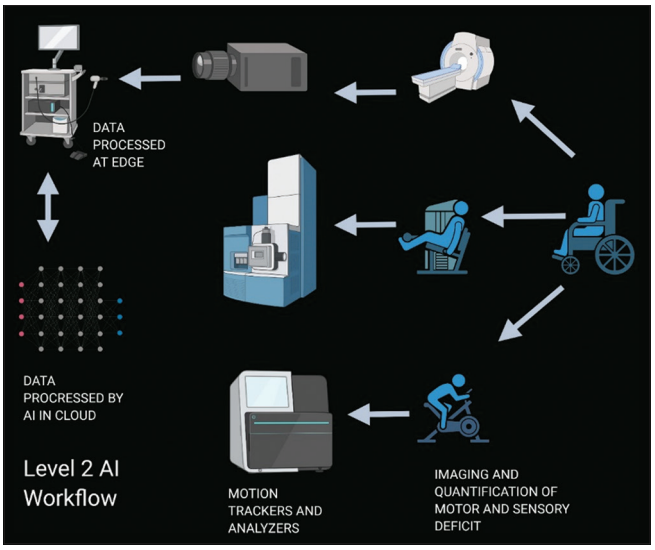

Figure 4: Disability analyzer

Primary care physicians

Primary care physicians will play a major role if this shift in assessment is to be made successfully. These physicians are usually the first point of contact for persons with disabilities. The proposed automated system will enhance the accessibility to certification of disability, and aid physicians in guiding the patient through the process of assessment. Constraints such as difficulty in traveling to the nearest assessment board, financial implications of such a journey, and the absence of availability of experts across the country and especially in rural areas pose a unique challenge in the assessment of disability in India.

Concerns

The new technology will come at a price, but this should not deter us as constituting medical boards have their challenges and economic issues, and it would be wrong to compare the two. Any new technology will require widespread acceptance. It is essential to mention the problems that AI can reinforce.

A potential source of bias arises if the training data lacks an adequate representation. It was commonly seen in face analytics systems with much higher error rates for black women than whites.[24]

Benefits

The benefits to the patient, the medical fraternity, the judiciary, and the society are immense and summarized [Table 1].

Table 1: The benefits to the stakeholders

Benefits to the Patient	Benefits to the Medical Fraternity	Benefits to the Judiciary	Benefits to the society
Transparency	Saves Time, Doctors can focus more on patient care, teaching, care and research.	Saves Time	Award of "just" compensation
Objectivity (The machine will give a similar result throughout the country)	Avoids the process of cross examination to a large extent.	Objectivity	Wide coverage of persons with disability
Faster processing	Ensures uniformity of and hence maintains harmony amongst the members of the medical fraternity.	Ensures Justice (The process becomes simpler)	No breach of privacy

Conclusion

Persons with disabilities form a sizable population as per WHO estimates. This article discusses how AI can help benefit the medical and the legal system, persons with disabilities, and society. If we are not consistent with the degree of disability, we cannot deliver justice in the real sense.

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Conflicts of interest

There are no conflicts of interest.

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