Viewpoint

Technology for dementia care: benefits, opportunities and concerns

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Keywords: Dementia, Technology, Patient Care, Home monitoring

https://doi.org/10.29392/001c.39606

Journal of Global Health Reports

Vol. 6, 2022

The rise in incidence and prevalence of dementia globally is driving the technological revolution to develop effective healthcare solutions for dementia patients and caretakers. These solutions promise enhanced mechanisms to manage lifestyle, monitor cognitive performance, ensure the security and safety of the elderly, and deliver rehabilitation services. In this viewpoint, we contextualize the role of technology in dementia care by elaborating on these solutions and discussing the associated benefits, opportunities, and concerns.

Dementia is a neurological disorder in which a person's cognitive and functional abilities progressively decline beyond what is expected due to biological ageing. Eventually, dementia patients become utterly dependent on the caretaker for their needs. According to the World Health Organization (WHO), more than 55 million people worldwide live with dementia, and every year 10 million new cases are reported.[1] The rise in the incidence and prevalence of dementia has led to the technological revolution in dementia care.[2] This viewpoint examines the benefits, opportunities, and concerns of technology-based tools in dementia care.

These tools can be either patient-centric or caretaker-centric (Table 1). The majority of technology-based solutions are patient-centric. Consequently, these hold the maximum scope for innovation, research, business, and growth. These are discussed in the following paragraphs.

Using technology-based devices to track and manage the lifestyle habits of dementia patients is a popular area of research and commercial interest.[3] Wearables, smart watches, or skin-friendly patches and straps are popular device types. These generally collect data on physical activity, nutrition, sleep, stress, motion, blood pressure, heart rate and blood glucose. The algorithms in these devices can analyse patient data and create actionable insights.[4–6] For example, in the case of dementia patients, lifestyle tracking devices can monitor their sleep quality and detect abnormalities or improvements. Accordingly, patients or their care-takers can decide to meet a physician or alter some lifestyle behaviours. A few commercial examples are Halo Wearable, Apple Watch, and Samsung Health.

In addition to lifestyle management, the safety and security of patients with severe dementia or those who live alone are vital. Embedded sensors play a pivotal role in ensuring this.[2,7] For instance, home activity monitoring of dementia patients uses data from sensors such as bed occupancy, night lamp usage, humidity, location, motion, gas leakage, flood detection, smoke, and enuresis. These systems can automatically inform care-takers or physicians in case of fatal events such as wandering, falls, or kitchen-related emergencies. An example is the CARU smart sensor,[8] which learns the expected baseline behaviour of patients and identifies deviations. Patients can connect with their family and friends through speech or touch control embedded in the CARU sensor.

While lifestyle management and security are beneficial for dementia patients, assisting them in maintaining independence is also vital for good quality of life. Rehabilitation of functional and cognitive abilities is instrumental in this regard. Tools based on technologies such as augmented reality (AR) and virtual reality (VR) can assist patients in cognitive rehabilitation therapies like reminiscent therapy, stimulated presence therapy, and multi-sensory therapy. Interactive games like MI-Tale can enhance logical reasoning and stimulate memory through interactive games.[9] Additionally, home-based training using robots can improve dementia patients in activities of daily living such as cooking, washing, feeding, grooming, dressing, brushing teeth, drinking water, and shopping for groceries.

Another critical consideration in dementia care is assisting patients with psychological distress. The use of robots

Table 1. Examples of critical areas in patient-centric and caretaker-centric dementia care.

Patient-centric	Caretaker-centric
• Lifestyle management • Patient monitoring and security • Behavioural and psychological symptoms of dementia (BPSD)	• Stress reduction and counselling • Enhancing awareness • Training in patient management

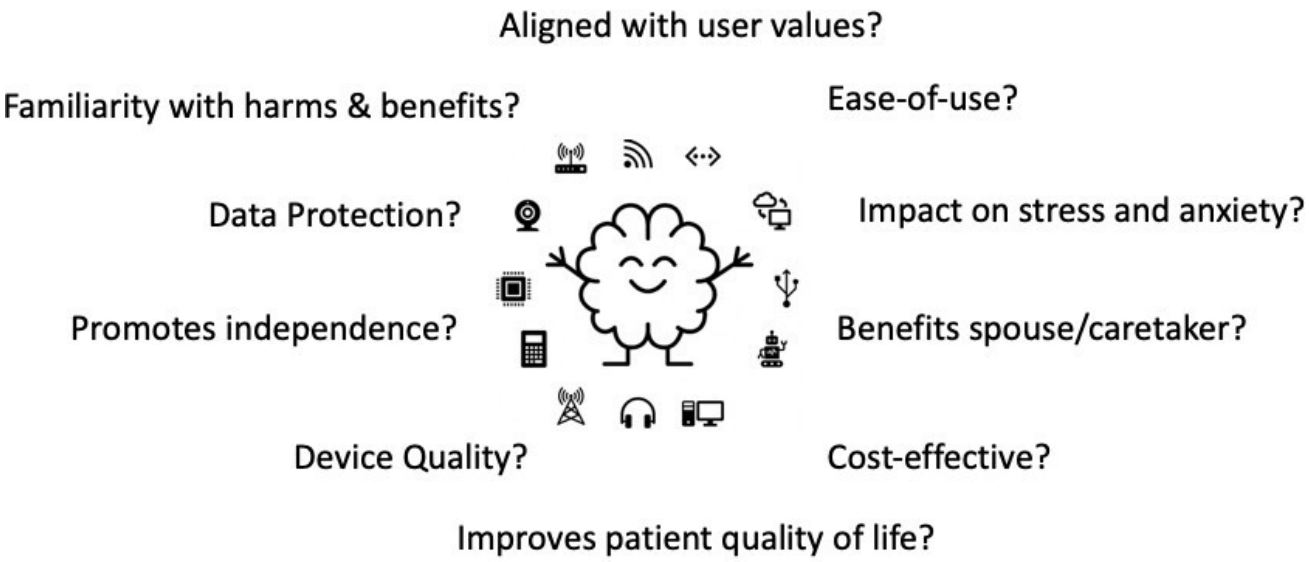

Figure 1. Graphic summarising ten essential questions before adopting a technology-based solution for Dementia patients.

These questions are adapted from [16] with slight modifications.

is widespread in this context (robotherapy). Evidence suggests lower agitation, depression, anxiety, impulsiveness, restlessness, and chronic pain among dementia patients and their care-takers due to robotherapy. These improvements occur over time, not necessarily immediately. A few examples of commercialised robots are PARO, NeCORO, Ollie the Baby Otter, and Hugby Laugh. Technology holds immense potential in this area because it is challenging to visit hospitals, physiotherapists or psychiatrists regularly. Home-based tools with feedback mechanisms can help dementia patients deal with behavioural and psychological symptoms.

The above-discussed technological intervention areas relate to managing dementia and cognitive decline. Still, early detection is a critical area wherein maximum impact can be created. Early detection can potentially delay cognitive decline through earlier treatment and intervention. Research is underway to detect dementia through non-invasive methods such as speech,[10] and gait analysis.[11] Machine learning models that can detect dementia early, based on images from Brain Imaging, Magnetic Resonance Imaging (MRI),[12] and Positron Emission Topography (PET) scans are also popular.[13]

Solutions designed for dementia care must focus on long-term care.[3] A deeper understanding of patients' and care-takers' expectations is fundamental. Systematic reviews and meta-analyses of technology usage in dementia care show that observed patient satisfaction is less than expected.[14,15] Encouraging patients and care-takers to audit a product or service before adopting it (Figure 1) can lessen this expectation gap. Secondly, it is essential to understand the nature of the gap (technical or conceptual) and improve the products and services accordingly.

Ensuring patient privacy is central to adopting technology-based dementia care solutions.[17] Dementia patients and care-takers must be informed about data collection and usage protocols. For example, in a home environment with embedded sensors, patients and care-takers must be informed about the type of data collected and the frequency and reasons for data collection. Patients and care-takers can then choose to restrict any sensitive information from getting collected. Moreover, solution providers must inform patients and care-takers about privacy risks and ways to tackle them. Prioritising patients' privacy fosters a reliable and trusted environment that assures quality services.[18]

Along with patient data privacy, ensuring the confidentiality of patient data is critical to building reliable partnerships between patients and solution providers. Information or data about dementia patients must not be shared or disclosed for monetary or non-monetary purposes without their permission. Protecting patients and care-takers from confidentiality breaches such as psychological distress, loss of employment, loss of insurance, damage to social reputation, and stigmatisation is essential.[18] Furthermore, solution providers must explicitly share mechanisms to handle, manage, and disseminate patient data. Lastly, solution providers must sign formal data-sharing agreements with patients and care-takers.[18]

Ensuring the security of collected data is essential to making data sharing successful. Given the surge in sensor networks in dementia care and the amount of data they generate, protecting these data from malicious attacks and misuse is an ethical obligation.[19] Solution providers must develop strategies to prevent disclosure, modification, disruption, inspection, destruction, and recording of patient data.

In addition to data privacy, confidentiality, and security, additional concerns exist for tools with integrated analytics.[20] Solution providers must inform patients and care-takers about the type and extent of analyses based on their data. Proper training should be provided to patients and care-taker on how to engage with insights provided by the

<table>
<tr><td colspan="2">Context: Community
Priority Criteria: Implementation feasibility, and potential impact.</td></tr>
<tr><td></td><td><u>Awareness (Low cost, high impact)</u>
Create massive awareness for Dementia and its:
• Symptoms
• Diagnosis Methods
• Treatment
• Health Care Facilities
• Risk Factors
• Prevention
• Prevalence and Incidence Trends
• Real Life Stories</td></tr>
<tr><td colspan="2">Context: Medical/Health Care
Priority Criteria: Patient needs</td></tr>
<tr><td>P1</td><td><u>Dementia Diagnosis and Cognitive Decline Tracking</u>
• Dementia Detection
✓ Non-Imaging Analysis (Linguistic/Speech based, Gait Monitoring)
✓ Imaging Analysis (CT-SCAN, PET, MRI, fMRI)
• Cognitive Deterioration Tracking</td></tr>
<tr><td>P1, P2</td><td><u>Cognitive Deterioration Slowdown Training (CDST)</u>
• Speech/Language Rehabilitation Training
• Executive Functions Training
✓ ADL Training
✓ Logical Reason Enhancement
✓ Interactive Games Therapy
✓ Multi-Sensory Therapy
• Motor Training
✓ Visuospatial Orientation Training
✓ Autonomous Movement Training
• Behavioural Training
✓ Psychological Disorder Management
✓ Wandering Minimization
✓ Sleep Disturbance Correction
✓ Supervised Physical Activity
• Memory Stimulation
✓ Reminiscent Therapy
✓ Stimulated Presence Therapy</td></tr>
<tr><td>P2</td><td><u>Home/Institutional Monitoring</u>
• Movement Tracking
• ADL Detection and Tracking
• Anomalous Behavior Red Flags
• Emergency Notification (Falls, Wandering)</td></tr>
</table>

P1=Patients reporting Subjective Cognitive Decline or recently diagnosed with Mild Cognitive Impairment.
P2=Patients recently diagnosed with Moderate or Severe Dementia/Alzheimer's Disease.
ADL=Activities of Daily Living.

Figure 2. Summary of minimal and most pertinent thematic areas for technological-based tools for dementia care segregated by context and priority criteria.

The listing sequence of these areas in the Medical/Healthcare Context reflects their priority for Patients P1 and P2. For example, for P1, Dementia Diagnosis and Cognitive Decline Tracking are the priority, whereas CDST is the second priority. In contrast, for P2, CDST is the priority, and Home/Institutional Monitoring is the second priority.

tools. Sharing patient data with third parties without consent must be punishable by law. Furthermore, solution providers must develop policies to resolve conflicts caused due to misinterpretation of the recommendations, faulty services, or incorrect usage of the tools. Such policies are particularly crucial in the case of dementia patients who suffer from cognitive and functional deficits.

Despite the challenges associated with technology-based dementia care and the meticulousness required in developing them, the overall outlook is optimistic (Figure 2). The challenges are real, and the impact is promising. A sound strategy would involve patients and care-takers in the solution development process and use their feedback to develop and refine the products and services.[2,21] Piloting the solutions in an elderly sample is suggested before the large-scale launch. A study of past failures and technology breakdown in the field can aid in the development stages.

In summary, dementia incidence and prevalence are rapidly rising, and technology holds immense potential to deliver continual quality services to patients. Long-term and continual collaboration with patients and upholding the ethics of data privacy, confidentiality, and security, are critical to achieving this potential. These actions would ensure that dementia patients receive the care and assistance they require, potentially minimising the pain and anguish they experience. Appropriate and urgent measures are necessary to accelerate progress in this direction.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the infrastructure and facilities at Cognitive Neuroscience Lab, BITS Pilani, K.K. Birla Campus, Goa India

FUNDING

The authors acknowledge funding support under strategic research projects from BITS BioCyTiH Foundation (a Section 8 not for profit company) hosted by BITS Pilani supported under the National Mission of Interdisciplinary Cyber Physical Systems (NM-ICPS), Department of Science & Technology (DST), Government of India.

AUTHORSHIP CONTRIBUTIONS

YB conducted the literature review and VB conceptualised the study. YB wrote the manuscript and VB helped in preparing the manuscript. Both authors have read and approved the manuscript.

COMPETING INTERESTS

The authors completed the Unified Competing Interest form at http://www.icmje.org/disclosure-of-interest/ (available upon request from the corresponding author) and declare no conflicts of interest.

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Submitted: July 20, 2022 GMT, Accepted: September 07, 2022 GMT

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