Improving community health-care systems' early detection of cognitive decline and dementia

PAD 20/20 Work Group on Community-Based Detection of Cognitive Decline and Dementia

Abstract

Preliminary estimates suggest that current global health-care systems lack the resource capacity to provide persons with dementia timely access to diagnosis, treatment, and care. There is an increasing need to improve timely identification of individuals who will likely progress to Alzheimer's disease (AD) dementia particularly among under-represented, underserved, and vulnerable populations. The rapidly evolving area of bioinformatics of health system data and the emergence of fluid-based biomarkers for pre-symptomatic AD may provide an innovative strategic option for health system planners. A think-tank style meeting entitled "The Campaign to Prevent Alzheimer's Disease Work Group on Community-Based Detection and Assessment of Cognitive Decline" developed recommendations to guide future sustainability activities, public policy campaigns, and implementation pilots. The group identified and explored different pathways of community-based detection using electronic health records, from different international health-care systems, to detect and surveil individuals with early possible cognitive impairment.

1 | BACKGROUND

Despite enjoying the current longevity revolution, global society is now on the precipice of a new form of political and economic instability. The crisis is composed of escalating costs for the diagnosis, assessment, treatment, and care of many age-associated disorders that affect memory, movement, and mood. Further, this burden is magnified doubly by the dementia and SARS-CoV-2 pandemics stressing already existing and inadequate health-care service delivery programs for older adults.[1]

Dementing illnesses, driven primarily by the most prevalent cause, Alzheimer's disease (AD), remain one of the largest global public health challenges facing health care today. There are now upward of 50 million people living with dementia and the global cost of dementia was estimated to be US$1.3 trillion in 2019.[2] Most of these costs occur in high income countries (HICs) although most people with dementia live in low/middle income countries (LMICs). If incident dementia predictions continue over the next 10 years, the global costs of dementia will increase to a projected US$1.7 trillion by 2030.[2] These global estimates increase to US$2.8 trillion by 2030 with corrections for increases in care costs.[2]

The global societal dementia burden is the key motivation for the various national and international dementia prevention initiatives over the past decade. The earliest efforts examined the issue of how to accelerate pharmaceutical intervention development. Next, the research community's focus shifted to explore opportunities to develop accurate assessment technologies in asymptomatic/early impairment individuals and to evaluate the effectiveness of non-pharmacological/lifestyle interventions. Today, there is a growing level of interest in identifying key public health opportunities that lessen the burden of disability due to dementia and its comorbid conditions at the community level.[3–5] The early and accurate assessment of at-risk individuals—in the real world—is an important topic.[6] The key questions facing health policy planners are:

1. Why attempt to detect cognitive impairment or dementia early if you cannot do anything about it?

2. How to identify those individuals at risk for cognitive impairment, within the confines of the existing lattice of global health-care services infrastructures, accurately and economically?

2 | CREATING A COMMUNITY HEALTH-CARE EARLY WARNING SYSTEM FOR COGNITIVE DECLINE AND DEMENTIA

In April 2022, the Campaign to Prevent Alzheimer's Disease (PAD 20/20) convened a roundtable of leading global experts in geriatric medicine, population health, epidemiology, bioinformatics, and pharmaceuticals to tackle an urgent mission: the development of an internationally deployable system to better detect early warning signs of cognitive decline and dementia, particularly among underserved and under-represented communities.

The work group's mission is to enhance capacity and efficiency for established global health-care systems. The effort seeks to leverage existing community-level health-care information from diverse systems of electronic health records (EHR) to develop profiles that will better detect individuals at risk or who have some form of cognitive impairment. The opportunity aims to establish a gated identification process to trigger earlier, more effective, and more efficient clinical care pathways.

With promising new treatments for AD and related forms of dementia now on the horizon, many millions of patients and their families now challenged by oncoming dementia may be spared unnecessary trauma, expense, and grief if we can create a triage program for care. Such a system may also alleviate burdens placed on primary care and specialty physicians from the predicted "silver tsunami" of aging individuals, 15% or more with some form of undetected cognitive impairment.[6] It may also help provide faster and more effective care to patients in underserved and marginalized communities who have long endured the brunt of the global dementia pandemic. For example, there is a clear recognition that vascular comorbidities disproportionately occur among under-represented communities in the United States, such as in Hispanic, Black, and Native American areas, as well as other understudied groups across the globe. Often, these populations experience vascular comorbidities that complicate and increase the burden of dementia. Because vascular changes represent among the earliest common precursors for subsequent sudden catastrophic events—including stroke—and slower neurodegenerative processes that lead to cognitive impairment, there exists a new possibility to provide affordable, accessible, and equitable dementia prevention.

3 | ESTABLISHING PATHWAYS TO ACCOMPLISH A GOAL

Healthy aging, as defined by the World Health Organization (WHO), is the lifespan progression of developing and maintaining functional abilities to enable well-being in later life.[7] Maintaining cognitive performance is a critical element of healthy aging as well as providing the best possibility for people to maintain personal independence and autonomy.[7] However, the detection of cognitive impairments is difficult, and even more so in earlier ages of the human lifespan.[8] Mild cognitive impairment (MCI) or even mild behavioral impairment (MBI) present difficulties in recognition and detection.[9–12] The reasons are varied including the use of different diagnostic criteria/classifications, time for longitudinal follow-up, and specialized training. There is a clear need for an ideal detection or diagnostic tool. The tool should be both sensitive and specific, non-invasive, intuitive, and scalable for use in both high and low resource clinical care setting. Moreover, this tool should be able to detect the slightest amount of cognitive decline in the shortest period of time—or borrowing from calculus, a cognitive performance derivative.

There are a multitude of challenges confronting the development of an ideal tool. The work group discussion broadly examined this question within the parameters of two primary constraints: (1) to monitor cognitive performance validly and reliably at the community or population level among those otherwise unimpaired, and (2) to perform this detection within the practical limits of existing health-care delivery systems. The use of health-care system medical information, or bioinformatics, offers one approach to improve the situation; however, there are other hurdles to consider for the development of approaches to support clinical decisions including detection, differentiation, prediction/forecasting, and ultimately diagnosis. One area includes the use of computer science, such as artificial intelligence (AI) or machine learning (ML). Several recent publications review the landscape that have been used to transform patient medical information into machine

RESEARCH IN CONTEXT

1. There is a growing level of interest to identify key public health opportunities that lessen the burden of disability due to cognitive impairment, dementia and associated comorbid conditions at the community level.
2. The PAD20/20 work group discussed how to use existing community-level health care information.The discussion focused on possible applications that could be developed from different electronic health records systems, across the globe, to develop clinical profiles to better detect unrecognized cognitive impairment or dementia. The ultimate aim is the establishment of processes to trigger earlier efficient clinical care pathways.
3. The proposed International Brain Watch Coalition seeks to address the fragmentation of clinical care services among those at-risk for cognitive difficulties. The Coalition's mission will be to lessenthe consequences of cognitive and physical burden associated with cognitive impairment and dementia at the community level, particularly among those who have been historically excluded from access to quality health care.

analyzable data.[13,14] These include ML, deep learning (DL), neural networks (NN), artificial neural networks (ANN), and natural language processing (NLP). In addition to selecting the most appropriate computerized decision algorithm (or algorithms), there is an essential need to have data that can be used to develop, train, validate, and ultimately verify that a decision algorithm provides useful and valuable information for patients. Finally, there is the formidable task of how best to drive awareness and adoption of computer-based decision algorithms for individuals, physicians, health-care systems, and payers. The task broadly covers the fields of implementation, organizational, educational, and communication sciences and management. The use of computational algorithms to support clinical decision making by analyzing structured and unstructured data like neuroimages or text note fields may be done more efficiently in the digital space. However, efforts such as the IBM Watson have demonstrated that computer-derived real world data solutions also must have the surety and trust of stakeholder that will rely on the resulting decisions.

There is a clear need to increase the detection of individuals with cognitive impairment that lead to better patient management, medical care, and social care. However, there is also an equally clear need to reduce the time burden, typically associated with the clinical detection of cognitive impairments and/or dementias, on medical systems already overwhelmed in terms of resource and personnel shortages. In exploring this problem, the work group covered four key topic areas related to the use of bioinformatic data and approaches to implement as a pathway forward.

3.1 | Topic # 1: Broad examination of necessary and/or sufficient elements for the detection of unrecognized cognitive impairment or dementia at the community level

First, the work group explored the data elements needed to successfully build clinical profiles and digital phenotypes with algorithms for the detection of MCI or dementia. There was recognition that AD and related dementias (ADRD) blood tests would enhance and promote efficient future community case detection. However, until such technologies become widely deployed, there was recognition that current digital patient health records do not generally have clear indicators of future brain disorders particularly those impairing memory. The discussion explored several options to address these challenges. The application of a risk-score model has been attempted by many teams and is widely reported in the literature. Yet, many of the published models fail to replicate or are not transportable among differing clinical bioinformatic systems and more diverse populations.

One general recommendation considered the development of detection algorithms as a reverse engineering problem. The general approach would be to calibrate detection by placing an emphasis on prioritizing who we should be testing. This is very different from developing novel or adjunctive tests/instruments and administering to everyone. Instead, the focus would be on the identification of high-risk individuals who should receive more extensive clinical or diagnostic observation. The generic example suggested was to use a well-characterized longitudinal observational research cohort of individuals whose dementia status has been firmly established and could be linked to an EHR from a clinical care database. From such a sample, the approach would examine 20% to 40% of the individuals living with cognitive impairment or dementia and explore relevant EHR clinical data (e.g., atherosclerosis, cardiovascular, metabolic, pharmacy, administrative, and other data) to develop a detection algorithm. The validation process of the algorithm could then be applied to the remaining 60% of the (unexamined) data. The verification and transportability of the algorithm would need to be applied using a second (or third, or fourth, etc.) joint observational research linked EHR clinical database to demonstrate stability of the algorithm.

There was general agreement to look at successful algorithm development efforts for other diseases like cardiovascular and cerebrovascular disease detection and modify as necessary. For example, today the Boston Medical Center EHRs use the Framingham Heart Study 10-year risk score for cardiovascular disease and this is computed and included every time a blood test measures cholesterol levels. The algorithm uses approximately five basic variables. The risk score is computed automatically by the EHR so that primary care physicians (PCPs) may use resulting information to advise their patients. There is a similar calculator for stroke risk stratification in atrial fibrillation. This is used to inform decisions to treat with chronic anticoagulation. The suggested constellation of constructs includes (but is not limited to) family history of cognitive impairment/dementia, vascular disorders, metabolic disorders, behavioral issues, cognition, aspects of lifestyle/environment, speech, as well as health administrative data.

3.2 | Topic #2: Options for designing and building digital applications

The work group examined the research and technical requirements to develop algorithms for early detection of cognitive impairment and dementia, as well as to test for reliability, validity, and verification. Outside the United States, in Israel, the second largest national health insurance program, Maccabi, retains a strong research collaboration with Sheba Medical University Center. This national EHR integrates with both the Medical Center's clinical research and observational data. One cohort includes a dementia registry, and the other includes a dementia offspring study (i.e., Israel Registry for Alzheimer's Prevention [IRAP]) that has an extensive 4-hour long neuropsychological battery, imaging, and some fluid collection (this study mirrors the Wisconsin Registry for Alzheimer's Prevention).[15,16]

In the United States, there exist several large clinical system networks that might provide data for development and testing purposes including Atrium Health Wake Forest Baptist, affiliated primary care providers, Surescripts, and AdventHealth (Florida). At one time, Premier Health contemplated a pilot of an EHR NLP algorithm as part of the AD site readiness study. Given the size of their hospital network and Premier Health's solution-oriented approach, this might be an ideal

testing ground. Also, the Centers for Medicare & Medicaid Services innovation group, the Center for Medicare and Medicaid Innovation, may be an important partner to support pilot project transition and scalability. The Davos Alzheimer's Collaborative has a flagship project with seven sites and six countries interested in potential collaborative research and development efforts. The Artificial Intelligence/Machine Learning Consortium to Advance Health Equity and Researcher Diversity project is an important initiative bringing AI/ML to advance health equity, researcher diversity, and public health challenges such as those posed by brain disorders. In summary, several different data networks exist that would enable pilot demonstration of a detection algorithm. However. future work will need to identify data sources, processes, and means of verification to support scaling pilot algorithms into general health-care systems.

3.3 | Topic #3: Strategies for the design and conduct of demonstration projects to detect unrecognized cognitive decline and dementia

The work group examined several methodological and analytical aspects of community-level detection of cognitive impairment and dementia using clinical bioinformatic data. Perhaps one of the largest challenges to develop a detection algorithm will be to provide assurance of the accuracy and economy of the methods to detect individuals with cognitive impairment in highly heterogenous populations of late adult age. A key goal will be to design demonstration projects that can provide evidence to satisfy multiple stakeholders including patients, families, PCPs, clinical health systems, payers, regulatory scientists, and the research community.

Here, the work group discussed pragmatic issues and estimated the necessary resources in terms of personnel, time, data, administrative, legal/ethics/regulatory, and other considerations to develop algorithms for the detection MCI and/or dementia in the United States and other countries. Using a single health-care system database as the smallest base unit, and with an aggressive project timeline of 12 months or less, the work group described a typical project team that has clinical/clinical database knowledge expertise (six to eight individuals), database programmers (six to eight individuals), computer/data scientists with possible experts with NLP and ML/AI (four to six individuals), and project management/administration (two to three individuals). This estimate assumes the use of fully contracted and dedicated project personnel, and the estimate also assumes a worst-case scenario for the quality of the data structure, the data libraries, and data dictionaries.

3.4 | Topic #4: Considerations for implementing an international public–private coalition

Fourth, the work group reviewed and discussed the roles for an international public–private coalition. The coalition would convene various stakeholders with interests in clinical health-care systems, patient/disease advocacy, medical education, patient/family/physician/health system readiness, and intervention/diagnostic technology development. The work group agreed that there is a clear need for a neutral third party to (1) validate, (2) verify, and (3) accredit newly proposed or modified detection algorithms of cognitive impairment and dementia. This coalition would serve as a coordination hub among other existing stakeholder association groups focusing on improving patient care for people with cognitive impairment and risk for AD/ADRD. The work group recognized the large investment and work already accomplished by other groups in terms of improving the dementia patient journey. Yet, there remains a distinct critical gap of how best to drive awareness, adoption, and acceptance of algorithms applied to EHR data to facilitate the detection of cognitive impairment and dementia within a range of global communities, and especially among those underserved and marginalized.

Although the US Prevention Task Force recommendations underpin the question "Why attempt to detect cognitive impairment or dementia early if you can't do anything about it?," there is a growing awareness among those in AD/ADRD research, clinical care, public health, health policy, and patient advocacy that the correct answer may be: There are many important clinically relevant options to consider.

This emerging viewpoint is strongly aligned with an important research debate that now questions if the primacy of efficacy-level data is sufficient alone or if it is necessary for the inclusion of effectiveness-level data, possibly more representative and more valid for community-wide health-care decision making.[17,18] The reality for many communities, particularly those from underserved, underrepresented, and other marginalized groups is that health-care systems are failing to provide quality and value services.

There is awareness that people do not want to receive an early diagnosis because their physician, their health-care system, and their health-care payer may not have the awareness to provide quality- and value-based care options. The work group discussed the necessity to develop early-warning detection systems to get individuals, in the most need of intervention, the very best options for a clinical pathway: not every cognitive disorder leads to dementia. Aligned with this recognition, there is a related need to have effective awareness and education campaigns that better inform health-care consumers, their families, PCPs, other health-care professionals, clinical health-care systems, and payers. There are important questions of how best to obtain buy-in from physicians so they will take an extra 5 minutes to use the information from validated algorithms in the future. Many people are offended by screening that is not presented in any context, so there is a need to educate people about the importance of a healthy brain. In totality, these points and recommendations will not be solved individually, but rather will necessitate the participation of many different stakeholders to develop implementation strategies. Any future public–private coalition will need to develop both top-down public policy solutions and simultaneously implement bottom-up coordinated solutions that will increase opportunities and new options for success. Specifically, any public education effort will need to provide clear and concise communication given the wide variation of general and specific knowledge about cognitive impairment and dementia. Work will need to manage the expectations of patients and families, and balance these against a

health-care system's implemented (current) risk reduction practices. Public engagement and representation in future work groups will be key, along with the participation of consumer health advocacy groups. Also, these future activities will need to consider carefully the process of global health messaging and its consequences on public opinion and education.

4 | FUTURE DIRECTIONS: INTERNATIONAL BRAIN WATCH COALITION

The launch of the International Brain Watch Coalition (IBWC) offers a promising new approach to address the complex issues surrounding fragmentation of clinical care services among those individuals experiencing some level of cognitive difficulties. Specifically, IBWC seeks to advance new approaches in detection, identification, and care of chronic brain disorders. The key outcome is to lessen the cognitive and physical burden associated with cognitive impairment and dementia at the community level, particularly among those who have been historically underserved, under-represented, and otherwise excluded from access to quality health care.

As a global coalition, IBWC envisions formation as a multi-stakeholder campaign—patients, caregivers, physicians, health-care systems, payers, policymakers, etc.—that seeks broad perspectives. The effort will focus on the identification and implementation of new approaches to deliver high-quality coordinated health care to address the ongoing problems of cognitive impairment and other disorders of brain aging. IBWC will dedicate a high level of attention to communicate and disseminate knowledge and educate the various disciplines, cultures, and geographies represented.

5 | CONCLUSIONS

Cognitive impairment and other dementing diseases, driven primarily by the most prevalent cause, AD, remain one of the largest global public health challenges facing health care today. Across the planet, there are now upward of 50 million people living with these conditions and the annual costs are estimated to approach US$1 trillion in 2022.[19] Together the prevalence of these conditions and the cost of illness represent a societal burden that will increase dramatically each and every decade through the century's end.[19]

In the United States as well as the rest of the world, this societal burden represents the most important motivation for the various national dementia prevention initiatives of the last 10 years.[20–24] The US National Alzheimer's Project Act, the UK Prime Minister's Challenge on Dementia, the French National Dementia Strategies, the Japanese New Orange Plan, and others represent the culmination of a series of initial research planning workshops/think-tank meetings organized by groups such as PAD (20/20),[21–24] Alzheimer's Association,[25] and the Organization for Economic Cooperation and Development (OECD).[26]

Spanning three distinct epochs for dementia prevention, these initial planning workgroup meetings laid the public health and medical foundation for several of these major dementia initiatives. The first stage of these meetings examined the question of how pharmaceutical intervention development could be accelerated and made more efficient for patients at different stages from mild to higher levels of impairment. This evolved into a second stage of discussions that explored the challenges and opportunities to design non-pharmacological intervention studies. The most recent meetings, including the present work group, are now examining those opportunities to center prevention activities for persons with dementia with effective service and treatment options. Today, the key public health objective now shifts to the identification of effective new opportunities to lessen the burden of disability due to cognitive impairment, dementia, and its comorbid conditions.[4,5,17,18,27–29]

The topic of diagnosis is critical to both the delivery of personalized health care, the conduct of research, and the establishment of public health policy for care and control of many neurodegenerative diseases. Although the present work group's initial focus was on the detection of unrecognized cognitive impairment and/or dementia, there remains a great need to strengthen the development of diagnostic classification systems to better ensure a person's brain performance remains generally unaffected as they age. This effort will need to span many different neurodegenerative disorders to account better for the co-occurrence and the interplay between disease mechanistic pathways and associated clinical symptoms that impair a person's cognitive, behavioral, and functional performance. At the time of this writing, several author groups are preparing position papers on a so-called classification system C/B/F, or cognition/behavior/function, that could provide the basis for such a framework for the AD field. In addition, the integration with the already existing A/T/N Framework[30] may provide one pathway to increase utility and accuracy of AD diagnoses.[31,32] Generalizing such an effort to other neurodegenerative disorders, as well as to make available to routine primary care, should be a priority for several coalitions pursuing improving global brain health.

The authors of this perspective article advocate that public health plans must expand the opportunities to prevent, treat, and o provide care for persons with dementia. Further, these plans must align with achievable clear public health targets. One attainable and measurable objective is the accurate and affordable detection and identification of people at elevated risks for cognitive impairment and dementia at the community level, particularly from those living in underserved and under-represented communities. In this context, enabling valid and reliable means of detection offers a new pathway to reduce dementia incidence as well as the morbidity of living with dementia.

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CONFLICTS OF INTEREST

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