

Artificial intelligence and aging: potential and precautions

Abstract

Since the introduction of artificial intelligence [AI] its ongoing impact and possible implications have been continuously discussed. Among these discussions are the possible implications and applications of AI for longevity promotion. This brief summarizes some of these ideas in the context of aging. Drawn from emerging literature on this topic, it is concluded benefits can be experienced currently in the realm of assessment, planning, diagnosis, and intervention. Some form of human AI interaction may be desirable for improving life quality, and age associated social isolation impacts than AI alone.

Keywords: aging, artificial intelligence, loneliness, machine learning, older adults, social isolation, prevention, treatment

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Introduction

Most societies today are experiencing an increasing number of older adults living into high age ranges, albeit with various infirmities. As life spans increase, and the birth rate and workforce personnel diminish as is currently demonstrated globally, not only is the goal of aging with minimal disability and a high life quality for all unlikely, but is likely to be impacted negatively for some time in the post COVID-19 pandemic years. Hence, efforts to understand the aging process, along with interventions and understandings that can help to avert or at a minimum alleviate some of the present age associated burden and public health costs are highly desirable and may be assisted by the emergence of various modes of Artificial Intelligence [AI]¹ and improved further over time by new insights derived from Machine Learning [ML] research.

In particular, how clinicians may help aging adults to adapt to age-associated changes and to achieve less severe or fewer age-associated deficits or levels of disability than would otherwise occur without intervention and preserving any preventable cognitive and mental health declines of the aging adult is critical to helping them age successfully and with intact autonomy. In this regard, AI may be helpful at least in some spheres for advancing this aim, while uncovering data pertaining to the biology of aging in its own right that may prove insightful.

Indeed, multiple applications that have emerged from AI technologies have already advanced the health and wellbeing of the aging adult in several spheres. It is also apparent that extending AI applications, including an enhanced ability towards early detection of any pathological age related cognitive, neurological, cardiovascular or physical decline may enable the introduction of more timely and thus more effective preventive and intervention approaches to maximize cognitive and physical health status. The same idea applies to the detection and monitoring of multiple chronic or life threatening physical conditions that commonly impact wellbeing in the later years, such as osteoporosis and falls susceptibility, diabetes, COVID-19 variants, and cancer. A device that can readily extract information in real time in regards to day to day behaviors is also likely to impact and prove of great value in respect to both preventive as well as the introduction of individually tailored health regimens and efficacious restorative processes.

Indeed, this emerging science of artificial intelligence or AI as applied to healthcare in general, as well as aging care in particular, and that involves the use of computational algorithms that mimic human cognitive and physical functional attributes can also analyze complex medical data quite readily. It can hence provide for better possible disease detection strategies and disease mechanism understandings, preventive or remedial age associated planning efforts, as well as providing for better predictions of the outcomes and suitability of various intervention options. This is because AI technologies such as machine learning [ML] can readily integrate biological, psychological, mental, physical, and social health related data that can be duly harnessed in efforts to establish diagnoses, prognoses, varied treatment options and costs. It can also serve to inform the individual about their situation and adapt its output to provide more personalized than generic responses.^{2,3}

However, is the AI technology advanced enough in 2023 to tease out the role of individual choices and behaviors, as well as effort in the context of aging that are key to efforts to foster the idea of ‘successful aging’? As well, can its use provide for a broad focus of age associated health issues, given the diverse nature of prevailing health policies, the basic educational level of the individual, their housing quality, medical care access and provision, their food access and quality, and appropriate employment opportunities-where desirable? Can AI enhance the degree of social networks and support needed to foster a meaningful and high quality individualized experience in later life currently needed by so many?

For example, can it solve or resolve some of the issues experienced by most older adults with disabling osteoarthritis of one or more joints who may exhibit some or many of the following features joint inflammation, joint instability, and joint stiffness, functional disability, limited energy, pain, muscle weakness, postural problems, helplessness, low self-efficacy, depression, and fatigue to a high degree without any human oversight?.

This paper serves to acquaint clinicians and other stakeholders with the use, benefits, and future areas of relevance as well as what limitations or possible ethical issues may preside through the unfettered and careless or ill considered usage of AI for fostering older adults’ wellbeing. It is argued that while AI is and will continue to be an enormous ground breaking and great advancement in terms of its potential ability to predict, diagnose, and classify mild and major

neural, cognitive, medical, and/or physical health impairments, these features may or may not be available or sufficiently well developed in 2023 and the near future to foster the health and life quality of all older adults who desire a dignified life and one with freedom to be autonomous and that is aligned with the attributes of resilience, acceptance, the ability to cope to achieve personally valued goals, and degree of valued independence, as well being based on validated and accepted evidence based practices. To this end, an attempt was made to present some observations that have emerged in the last five years [since the COVID-19 pandemic onset]. These are not all inclusive but are presented in general and may or may not apply to all:

- 1) demographic factors;
- 2) clinical and psychometric assessments;
- 3) neural imaging and neurophysiological and radiographic evaluations;
- 4) community based or other forms of health care and settings;
- 5) situations where supervision is more relevant than vicarious interventions, and
- 6) all forms of chronic illness.

The discourse too may not address all pertinent data on the influence of cultural and lifestyle preferences, health provider beliefs and preferences, technological skill and availability, and the role of age ranges and longevity associated needs at different ages as far as AI is concerned.

Nonetheless, if it assumed that fewer health care resources and workers will be uniformly available and accessible in almost all countries in the near future, what are AI opportunities in 2023 and beyond that may be helpful for mitigating much future distress among so many?

Methodology

Using the electronic data sources PUBMED, PubMed Central, and Google Scholar articles published in the past five years [January 1, 2019-June 14 2023] using the key words, Aging, Artificial Intelligence [AI], Machine learning [MIL], Older adults, and Longevity was undertaken. All forms of reports were deemed acceptable, including any salient commentary papers. However, because this is an emerging topic, with few clinically sound prospective analyses, and most reports were review articles on isolated themes, rather than clinical trials, a narrative summary of all selected data of possible articles relevant to the use of AI in aging and longevity contexts and how AI can possibly be applied to foster life quality was deemed of high relevance, rather than general applications, or applications involving children or adolescents. Excluded were articles that did not focus specifically on this set of issues, and those that were non English based articles. For a comprehensive overview, the article by Shi et al.,⁴ is recommended.

Results

Artificial intelligence usage possibilities

Among the wealth of current artificial intelligence [AI] publications, possible uses of AI documented to date include, but are not limited to: diabetes retinopathy screening,⁵ early dementia detection,⁶ imaging and age associated macular degeneration,⁷ mental health care and other illnesses at an earlier or prodromal stage where interventions may be more effective and personalized.³

Jia et al.,⁸ describe an AI application whereby it is used to better understand spatial life course epidemiological attributes that

utilize advanced spatial, location-aware, and artificial intelligence technologies to investigate long-term effects of measurable biological, environmental, behavioral, and psychosocial factors on individual chronic disease risk. It is also proposed that AI can help to foster research on infectious disease dynamics, risks, and consequences across the life course, as well as for solving social problems that plague society.⁹

In the context of aging, AI may also serve to help encompass a heightened form of decision making in the home by the older person living or wanting to live independently, which encompasses the use of AI to automate home safety risk prevention, and the ability to respond to real time emergency situations. It is also important to note that AI in this regard is deemed minimally intrusive, and can use plug-and-play sensors and machine learning algorithms to learn about the older adult's daily activities taking into account their health records. If the system detects that something unusual might occur (in a wide sense) or if something is wrong relative to the user's health habits or medical recommendations, it can send a real-time alarm to the family, care center, or medical agent, without human intervention. Knowledge of the subject's physical activities can be collected by mobile applications as well as by their personalized health information on record and embedded in the system. The system usability and reliability have been tested in real-life conditions, and show a greater than 81% degree of accuracy.¹⁰

Other possible applications include the continued development of virtual medicine¹¹ and the improved detection of osteoporosis and fracture risk¹² in light of age, frailty and life expectancy.^{13,14} Lotsch et al.,¹⁵ report artificial intelligence and machine learning approaches can also be applied to assess and treat pain-related data and conditions such as low back pain, arthritis pain, neuropathic pain, and inflammatory pain.

Another realm of usage is that of osteoarthritis care. As discussed by Lee et al.,¹⁶ AI offers a promising solution in efforts to foster more accurate detection and management ability as far as knee osteoarthritis is concerned, including surgery to the knee.¹⁶ This includes an improved ability to enhance decision making,¹⁷ diagnoses¹⁸ and intervention outcomes¹⁹ and for guiding the available treatment options desired for different osteoarthritic disease stages.²⁰

It can also be used to provide estimates of the nature of the living space that it might help to favorably impact behaviors, functionality, and psychological issues that can limit as well as detect possible 'loneliness'.^{21,22} As well, AI may be able to further advance technologies such as robotic pets and some other social robots that can help to alleviate loneliness to some extent if an older adult requires this.²³

As per Ho,²⁴ as life expectancy continues to rise, many countries experiencing severe shortages of direct care workers, as well as health workforce aging situations, their replacement remains a challenge and is one where AI health monitoring and technologies may be harnessed to play a novel and significant role in filling these human resource gaps, while reducing the burden on family caregivers, and improving the quality of care for an aging adult in need of support. This in turn, may empower them, while improving their quality of life and keeping them safe.

In short, as artificial intelligence systems develop, it is anticipated that their diverse aspects will be increasingly applied in various aspects of aging health care. These possible applications include but are not limited to- the application of holistic assessments and intervention processes and stronger solutions for uncovering individualized and

age associated physiological mechanisms that underpin aging and their possible solutions. The ability to generate timely evidence based health solutions and to propose possible novel ideas, such as the development of molecular compounds with desired anti-aging properties has also been discussed. In addition, these novel techniques can be combined into a unified, seamless end-to-end health status profile, and a targeted array of intervention solutions that can be personalized readily. Also cited in this regard are innovations in longevity biotechnology, as well as in the healthcare and pharmaceutical industry.²⁵ Studying ‘long-lived’ individuals through AI may further reveal the presence of any protective behavioral, environmental, and molecular factors that can effectively help reduce risk or delay the onset of most if not all age-related disabilities and diseases.

This may include data sets that map the complex, multilayered interplay of genetics, metabolism, proteins, and other variables, along with possible imaging and clinical data swiftly and efficiently and the ability to track various health indicators and foster an independent life of high quality, as well as reduced social isolation and family related burdens,¹ while increasing availability of health care services²⁶ and leading to new discoveries to advance healthy aging,⁷ plus more accurate chronological age predictions.²⁷ As per Ma et al.,²⁸ areas of promise include, but are not limited to, examining the role of AI devices in the form of robots, exoskeletal devices, intelligent homes, AI-enabled health smart applications and wearables, voice-activated devices, and virtual reality applications. One or more of these approaches may be especially useful in the context of rehabilitation, the provision of emotional, instrumental or tangible support, and the fostering of social and interpersonal communications.

Kato et al.,²⁹ describe an approach to employing AI as a nursing care-support device by its ability to develop robotic technology that can potentially reduce a nurse’s task burden in long-term care facilities. The introduction of nursing care-support devices such as robotic technology is also expected to offer long term care patients more movement and life space options as well as psychological benefits.

A conceptual framework of compassion informed by Morrow et al.,³⁰ is also being incorporated into possible AI applications. This compassion associated re-conceptualization of its dimensions is deemed essential for purposes of use in various AI realms. It currently embodies the need to consider six desirable care elements including:

- 1) A demonstrated awareness of suffering;
- 2) An understanding of the collective meaning and impact of suffering;
- 3) A means of identifying in a desired manner with the suffering;
- 4) An ability to make accurate judgments about the suffering;
- 5) An ability to respond meaningfully to alleviate the suffering;
- 6) A means of attending to the response effects and outcomes of exposure to suffering.

These elements, believed to alleviate different types of suffering can operate at an individual (human or machine) as well as at a collective level as a cyclical system. These systems are projected to offer novel approaches that can enable human-AI intelligent caring and are expected to enrich educational efforts, learning, and clinical practices.

Challenges in AI usage

Despite multiple favorable applications and potential of AI in the aging realm and others, grand challenges in relying on this approach

as a standalone strategy currently include, the need to successfully assimilate genetics and other determinants of health into precision medicine data sets that can translate across different ancestries,⁹ diverse diseases and distinctive populations.³¹

Even then, as per Zelenak et al.,³² cloud technologies that provide real-time data analytics from various sources across integrated organizations and data sharing need to be carefully balanced and information security must be guaranteed and the risk of cyberattacks prevented. Other problems include data ownership, patient monitoring, location identifiers, and variations in disease classifications. In addition, while possibly useful in stroke or cardiac symptoms identification and diagnoses, the detection of these situations does not necessarily translate into effective timely treatments at present.

Moreover, if employed as a means of wearable identification, or through the use of robots that collect information, AI could cause confusion by users who are not tech savvy or bewildered by technology or do not want to disclose personal issues to a non-human. As per Vercelli et al.,²³ care robotics that are designed to reduce human contact, and may be helpful, may also have the effect of increasing the objectification and loss of control of those older adults who value privacy and personal freedom (especially if robots only perform restrictive or isolated actions). Moreover, the use of robots among older adults may raise the risk of confusing them as to why their human providers are employing technology rather than face to face consultations, along with a possible chance of the risk of deception and infantilization.

Distrust of a system that may capture data for nefarious reasons, and that cannot be checked or edited readily by the individual, where informed consent may not always be obtained or understood, as well as its restricted usage as far as promoting only certain health perspectives, not others, may appear manipulative and coercive, as well as sub optimally efficacious or non-effective. At present, as well, it cannot be readily discerned if the health data base is problem free or replete with problematic studies that include limited samples or data that do not represent a particular client in salient ways. In addition, current data may not speak to the issue of health disparities or diversity needs in multiple spheres in a predictive manner in many instances, or a clinicians lack of insight into how to maximize AI usage and health outcomes. Moreover, the role of patient subgroups, and whether publication bias and other biases prevail cannot be determined or currently accounted for or validated to any meaningful degree.³³ The system may also fail to address the idea of natural healing or include data that are not considered medically mainstream, for example, herbal or alternative medicine approaches and the various interpretations of disease in these and other models.

Additionally, preferences for or against technology may not be uniform or generalizable. Moreover, the blanket use of AI like devices as a substitute for human contacts may not appeal to the older adult who prefers to trust and employ human oriented and delivered communication interactions. As well, at this point in time, AI ‘insights’ may not include the key role of culture, access, affordability, and health literacy, and may well do more harm than good if its use increases the risk for isolation of the older adult who is not tech savvy or reduces service access and family communications.

There may also be a current limitation in the ability of AI systems to fully appreciate the complexity of longevity issues,³⁴ all forms of language and dialects or accents, or the possible limits on independence if too much passive assistance or no interpersonal communication opportunities prevail. Additionally, AI may not be sufficiently advanced to detect environmental issues affecting safety,

and to avoid predictions that may evoke an older adult's distress, and some current attempts at data collection appear more for purposes of research than for therapeutic purposes.³⁵ Moreover, knowledge gaps and limited collaborative research foci may undermine the value of AI, and especially if there are research flaws, discrepancies between studies and what has been assessed and that are not duly identified or resolved.¹²

According to Ho²⁴ it is only when we begin to design AI health monitoring technologies that include the intersection of clinical and ethical factors that the resulting systems will be in a position to enhance relational care, facilitate independent living, promote older adults' health outcomes, and minimize waste. Their ability to integrate a human focus however, may yet create privacy issues that limit advancement unless carefully considered.³⁶

At the same time, as per Latikka et al.,²² blanket usage of AI in the face of no long term study of its impacts should proceed with caution, as future studies may show very different outcomes than those consistent with current expectations based on traditional research findings conducted in the clinic. For example, in health communication contexts will the elderly engage in conversations with a robot freely, and if the conversation and the data transfer are to be utilized for remote consultations as well as some straightforward environmental and public health checks as described by Shi et al.,⁴ will they offer feelings of self-esteem or belonging or love or convey their unmet needs instead. While Shi et al.,⁴ state robot delivered physiotherapy is as effective as clinic visits for older adults, is there any rigorous evidence this will be an effective public health approach if indeed the older adult has both visual as well as auditory and memory challenges and severe hand osteoarthritis for example and can't use a smart phone or understand the robots directives. Moreover, a comparative role of other strategies may also show a hierarchy of what would be best for intervention purposes in a particular case, rather than relying on generic approaches.³⁷ Kemperman et al.,³⁸ note issues of great import in this regard are feelings of loneliness that are directly related to satisfaction with one's social network and neighborhood attachment and are indirectly related to perceived safety and satisfaction with local amenities and services, rather than whether technology is available or not.

In short, although not well researched, it appears AI is an emergent and conceptually accepted highly versatile innovative tool of enormous potential that can be applied to advance wellbeing, but is currently limited in multiple spheres that need to be carefully researched and addressed.

Discussion

Since 2019, an immense explosion in the field of AI has clearly been ground breaking. While currently limited in multiple spheres, one can only admire its current ability to foster health advancement opportunities and realities in diverse ways. Moreover, as the population ages, in terms of fostering health across the lifespan, secondary and tertiary disease and disability prevention, AI presents us with enormous potential for advancing longevity and its costly burden. It can connect many facts that exist in real time and enable new as well as personalized insights that can be harnessed to advance health and health decision making as well as new concepts and directives. Caregiver burden may also be alleviated in many ways by the AI derived products and services. Health planners too may benefit from being able to make more firm short and long term predictions. Diagnoses of many chronic health conditions can possibly be made earlier and effectively treated if their causes are more readily revealed.

According to Renn et al.,³⁹ artificial intelligence in healthcare aims to learn patterns in large multimodal datasets within and across individual that may either improve understanding of their current clinical status or predict a future outcome or both. In this regard, AI has the potential to not only revolutionize chronic health disease prevention and intervention,⁴⁰ but geriatric mental health care and research and other facets of health by its advanced ability to carry out diagnoses, advocate treatments, and aid clinical decision-making.

Among many other applications or possible uses, Park et al.,⁴¹ detailed an AI type approach that enables medical staff and others to monitor a patient's condition from anywhere including the emergency room, the recovery room, and nurse's station, by using tablets or smartphones. Meanwhile, findings from studies that reported improvement in diagnosis sensitivity and specificity by applying machine learning to the multi-biomarker analysis have been used in real-world cases to classify cancer-related biomarkers; and diseases such as dementia,⁴⁰ as well as for expediting hospital based health care delivery and management.⁴²

While its possible misuse or excess use should be scrutinized and data eliminated if proven erroneous or misleading, data should currently be validated rigorously through other channels as the emergent AI data derived from large data sets in many cases may depend on what was collected or not, and their research validity and general relevance to the situation at hand, and must account for language barriers and what prompts are applied or not. The state of the art in many aging realms is however still likely to be fraught with many gaps, and to be based on multiple view points, limited and poor research designs, and uncertain evaluative and outcome measurement properties among other factors.

As such, human guidance and concurrent ongoing analyses of AI health recommendations and their outcomes currently appears of high import as well as for future public health purposes and others. Questions such as how AI can mitigate frailty, rather than simply diagnosing this and issues related to climate change, poverty, social inequities, and how to build a more resilient aging society appear highly important to consider as well. Unfortunately, current AI health recommendation and insights stem largely from large data sets—that may not be inclusive or without error or limitations, electronic medical records or randomized published trials that may not include those who have no provider, have undiagnosed frailty, or are frail due to poverty, or exclude those who did not meet study criteria or did not complete the study.⁴³

At the same time and according to Jeste et al.,⁴⁴ it is not intelligence, but wisdom, that is associated with greater well-being, happiness, health, and perhaps even longevity of the individual and the society. Thus, the future need in technology is for artificial wisdom (AW) not simply improved intelligence alone.^{45,46}

In the interim, AI and ML approaches may undoubtedly help health personnel to avoid burnout, costs may be curtailed, and more precise care may emerge in efforts to help the enormous body of older adults worldwide to cope with life more effectively in general, regardless of physical health status, and across all stages of the older adults' life trajectory.⁴⁷ Early life based interventions and improved diagnostic approaches can also be predicted to foster greater wellbeing and longevity for many as well as health care savings. The provision of health education materials and resources and services that can be advanced through AI as well as automate decision making and patient related predictions⁴⁷ may also prove life affirming for many, as might its enhanced social media applications such as virtual reality, and tailored network linkages, especially if they place emphasis on

what success means to the aging individual at the outset, rather than attempting to advise them to follow prescriptive or preconceived practice based models. In the case of the osteoarthritis sufferer, one who proactively tries to maintain a full and independent life by means of their own efforts to accommodate certain physical changes, to prevent harm, and to promote regenerative or reparative states, they may well feel less depressed, and more efficacious if supported and guided by AI. They may hence feel very satisfied as well as successful despite their disabling health condition. Similar analogies can most surely be applied to mitigating or averting multiple aging states and adverse health conditions or disabilities, and health providers are strongly encouraged to gain a comprehensive understanding of the AI potential in advancing health across the lifespan and its strengths and limitations.⁴

The potential for AI to foster optimally safe and enriching living environments may further enable improvements in self-care activities, mobility, recreational opportunities, social interactions and internet mediated community-based health promotion programs to many. Public health workers may find AI highly advantageous for promoting mass communications and needs based resource allocations that can reduce age associated health disparities in diverse ways, as well as time and monetary costs.⁴⁸

At present, however, many gaps in our knowledge prevail, and it is also conceivable that unintended consequences of AI that have not been studied to any degree may reveal that its usage can heighten rather than reduce feelings of depression experienced by an older person, and an enhanced lack of confidence in its directives by those already marginalized in the health and socioeconomic realms. Trustworthiness of the system is also not a given. Thus, as per Park et al.,⁴¹ it appears that for the emergent AI technologies to be optimally successful, and more actively applied in health care, the general public awareness of AI should be based on much more extensive and large data sets as well as its evidence based health opportunities, rather than fear provoking approaches alone. However, here the establishment of standardized and legal guidelines concerning its use should be forthcoming and widely publicized as soon as possible. Further systematic improvements to address the older population's digital skills and beliefs about the value of vicariously delivered service provision, along with those to allay anxiety about any possible AI data disclosure leakages, data sharing or usage and/or feelings of apprehension over invasive diagnostic mechanisms such as facial recognition and genetic profiling should be sought continuously, in addition to any technological improvements and advancements.^{45,46,49,50}

Conclusion

A review of key reports discussing AI and ML as applied to aging health care practices and opportunities, while basically emergent and only being largely conceptual at present in mid 2023, reveals several insights to possibly acknowledge and expand upon:

- 1) Artificial Intelligence (AI) and Machine Learning (ML) are innovative analytic systems that may be of collective advantage to apply in multiple aging associated and possibly interactive health spheres including diagnoses, planning, delivery, and intervention selection, as well as in providing for predictive data and improved decision making.
- 2) More research on how AI or ML technology can enhance life quality while reducing its possible invasive and counter privacy operating mechanisms will prove fruitful.
- 3) Efforts to examine whether AI type devices that can be worn or 'wearable's' are able to detect possible adverse events with a high

degree of accuracy, and low chance of false alarms or possible usage associated anxieties using large diverse data sets may be helpful as well.

- 4) As well, whether their applications are practical for those older adults with multiple health concerns and limited manual or visual, auditory, and cognitive skills requires future study.
- 5) Educators and clinicians as well as researchers should educate themselves about all aspects and advantages of AI and ML usage and its care potential for diverse older adults, and its possible favorable ramifications, while remaining mindful to address any related ethical, regulatory, ethnic ageism, safety and social inequity challenges or hazards that may otherwise emerge inadvertently to undercut its utility.
- 6) Distinguishing the preferences for or against AI/ML as a standalone health medium to advance age associated wellbeing, as well as its practicality should not be overlooked by funders as well as by those seeking to afford optimally efficacious and personalized aging care to adults of all ages no matter where they reside.

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Conflicts of interest

The authors declare they have no conflicts of interest that are directly or indirectly related to the research.

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