Fake brain helping human brain

Artificial intelligence in mental health care

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ABSTRACT

Mental health disorders affect 30% of the world's population and rates of diagnosis continue to increase. This huge global burden on the individual and societal levels requires enhancement of current diagnosis and treatment. Artificial intelligence (AI) offers novel approaches to diagnosis in mental health care. Personal digital devices that have become omnipresent in the developed world can be used as sensors for continuous monitoring of an individual's behaviour. Analysis of behavioural markers such as sleep, social media use, and communication patterns through the use of sensors creates a patient's digital phenotype. Continuous monitoring offers an insight into patients' regular behaviour that is different from the self-reported, momentary snapshot used in conventional diagnostic practices. Virtual humans offer an alternative way to collect information, allowing for increased patient disclosure. Current applications of AI facilitate access to mental health care by monitoring patient functioning in real life and immediately connecting patients to appropriate resources. Despite many benefits of AI in mental health care, further translation of this innovation from research to clinical practice requires diligent policy making to address privacy and confidentiality concerns.

INTRODUCTION

Increased focus on mental health disorders has allowed for a more open dialogue regarding their prevalence and a more precise estimate of their epidemiological significance.¹ Various international studies estimate that a third of the world's population is affected by mental disorders, and the rates of diagnosis continue to increase.^{1,2} Global burden is aggravated by high co-morbidity, as several mental disorders often occur together.³ Cost to individuals and society is immense, as mental disorders negatively affect quality of life, economy, and longevity.^{4,5} Conventional diagnosis of mental health usually depends on the health care provider's interpretation of patient-reported signs and symptoms with respect to diagnostic criteria and classification systems.^{6,7} However, the process has several limitations, such as patients' lack of disclosure, providers' inadequate recognition of variable disease presentations, and systemic constraints including time and productivity pressures.^{7,8} A solution to many of these challenges could lie in the use of artificial intelligence (AI), whereby various devices collect and analyze patient data, and the process of machine learning (ML) develops appropriate algorithms to recognize and treat mental disorders.^{8,9} This review will discuss applications of this concept in mental health care, as well as advantages, barriers and important

considerations with respect to increased digitalization of care.

ARTIFICIAL INTELLIGENCE AND MENTAL HEALTH

Considering that psychiatric disorders have a diverse variety of presentations, one way to improve diagnosis and treatment is access to a more personal and continuous monitoring of a patient's status.^{7,8} Potential sensors for collection of a wide array of behavioural information include smartphones, smartwatches, computers, social media, and online browsing, which have become omnipresent in the developed world.^{8,10} Patients, consciously or not, are constantly inputting data into these devices, which could be used for mental health diagnoses.^{11,12} Such data includes communication type, frequency and duration of communications, hobbies and interests, sleep patterns, and physical activity.^{11,12}

Using accelerometry, wearable devices and smartphones allow for continuous monitoring of physical activity, which is both an important diagnostic marker and treatment modality in mental health.¹¹⁻¹³ Online browsing reveals personal hobbies and interests, while social media posts contain verbal cues related to mental health diagnoses.^{11,14} Sleep patterns can be monitored through screen lock times and battery usage.¹¹ Finally, communication frequency, timing, duration, and type (via social media, text messages, or phone calls) may be indicative of relationships and support networks present in the individual's life.¹¹

Collection of these diagnostic behavioural markers allows for digital phenotyping—continuous quantification of an individual's phenotype using digital devices.¹² Digital phenotyping is a useful tool for determination of the patient's baseline functioning in real life, which may be different from that observed in a health care setting. Additionally, it allows for real-time monitoring of any changes to determine risk factors and offer appropriate interventions.^{12,15}

Another innovation in mental health diagnosis involves the use of virtual humans to collect patient data.^{16,17} While conventional interviews in health care setting are conducted by a human, advances in technology can replace the interviewer with an interactive 3D projection of a person on the screen, who can be fully automated to conduct a semi-structured interview.^{16,17} ML can analyse linguistic and paralinguistic cues in the patient's response and direct the conversation accordingly.^{11,17} Besides collecting verbal input, the virtual human also recognizes non-verbal cues, analyzes the patient's emotions and responds appropriately, helping to establish rapport.¹⁷ Studies have found that this advance in AI facilitates patients' disclosure by reducing perceived judgement and fear of negative evaluation, as well as increasing the sentiment of privacy.¹⁶⁻¹⁹

IMPLICATIONS TO PRACTICE

In comparison with conventional practices, AI applications offer insight into the daily lives of patients, which is different from what a health care provider can observe in a health care setting.^{8,11,12} AI analyzes a variety of data input to create an individual digital phenotype.¹² Some of the aggregated behavioural markers are important in conventional mental health diagnostics.¹⁰ For instance, sleep disruptions and reduced social contact have been linked to depression.^{10,11,20} In conventional practice, this type of data would be self-reported and could be skewed by an individual's perception, but digital devices allow for thorough and continuous monitoring and evaluation of these markers.^{10,11} Similarly, conventional diagnostic markers, such as linguistic cues, can now be observed in various social contexts.^{8,11,12} Social media posts can be monitored for manifestations of hopelessness, increased self-attention, and reduced coordination with the community, which indicate patterns of depression and suicidal tendencies.^{11,20} ML and predictive modeling can foresee depressive episodes and allow for timely interventions.^{8,21}

Besides conventional diagnostic markers, the advent of technological innovations permits the use of behavioural markers which are difficult to perceive, quantify, and analyze using conventional practices.^{11,12,22} An example of such markers are paralinguistic cues such as vocal pitch, rate, inflection, and tone.^{11,12,16,22} These cues are part of conventional interviews but a practitioner may interpret these subtle metrics in a more subjective way than AI, which utilizes more rigorous voice analytics.^{11,16}

Technological advances facilitate access to health care by automating the process of data collection that can be used in diagnosis, and connecting the person to the appropriate preventative and treatment services.^{23,24} This is particularly important considering the constraints of our medical system.²³ An example of current applications of AI in psychiatric care involves Tess the chatbot.^{9,24} The chatbot works as a personal coach, helping people work through difficult situations using cognitive behavioral therapy.^{24,25} If Tess recognizes any risk factors in a patient's text messages, it immediately communicates this to a therapist, who is then able to intervene appropriately.²⁴ In traditional access to care, patients need to endure long waitlists before accessing any screening or diagnostic services.¹² During this time, their condition could advance to require more complex interventions.¹² AI streamlines the diagnostic process, offers immediate interventions, and connects the patient to professional help if needed.^{12,24} Such an application of AI facilitates access to care and optimizes health care delivery.²³⁻²⁵

FURTHER CONSIDERATIONS

While AI and ML offer significant benefits in the diagnosis and management of mental health, there are some concerns associated with this innovation.¹⁰ Although studies have found an increased sentiment of privacy and patient disclosure during interviews with virtual humans, it may be challenging to overcome privacy concerns when it comes to AI analysis of smartphone and social media use.^{10,11,16} Considering the breadth of data that may be accessible from such devices, patients may be hesitant to have this

data analyzed by the machines and linked to their health status.^{10,15,26} As with many innovations, the concern becomes when, how, and who will have access to this information.²⁷ Rigorous control and consent measures will be necessary to ensure patient privacy and confidentiality in the translation of these innovations from research to clinical practice.^{27,28} On the other side, marketing companies already undertake a significant analysis of the population's digital device use.²⁶ Potentially, a significant part of that data would overlap with health-related data, and the balance between these datasets would be an interesting area of investigation and an important factor in policy making on the subject.²⁶⁻²⁸

CONCLUSION

The global burden of mental health disorders is high: they are estimated to affect a third of the world's population, with rates of diagnosis continuously rising.^{1,2} These conditions have significant implications on individuals and on Canadian society, affecting daily functioning and quality of life, and costing Can\$51 billion per year to the Canadian economy.^{4,29} AI applications in mental health care could facilitate and expedite access to care, allow for early diagnosis, and promote timely interventions.^{8,11,12} AI allows for more continuous monitoring of patient status, but raises some privacy concerns which would need to be addressed by policymakers in the process of translation of this technology from research to clinical practice.^{11,26,27}

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