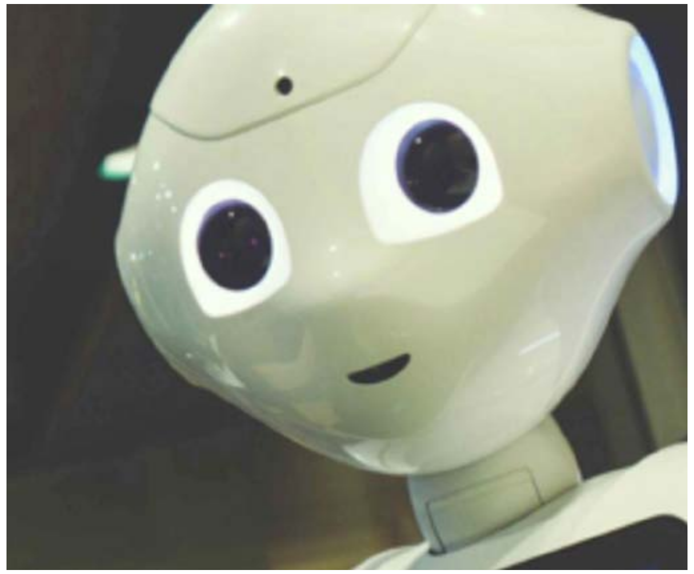
Intelligent Care Machines – Developments in Artificial Intelligence for Mental Healthcare

Dr. Nabil Georges Badr
Digital Transformation for Business Value



Artificial Intelligence (AI) is the science and engineering of making intelligent machines, with all what it entails of technology, data management and analysis components. The top goal of AI is to build machines that are capable of performing tasks that we define as requiring intelligence, such as reasoning, learning, planning, problem solving, and perception[i]. AI techniques, such as natural language processing and affective computing, give rise to life-like artificial beings, interactive, and engaging.

In medicine, AI implementations enable the proliferation of robotics for surgical and bedside care. AI is also used to increase the effectiveness of medical diagnosis (through image recognition for early disease detection and predictive analysis), medical records (using natural language processing to enrich structured data entry and augment decision support systems), statistics, genetics, and to deepen the learning of human biology in general.

Intelligent Machines Are Better at Some Things

Intelligent machines offer several advantages at the service of the patients and their healthcare professionals. Modern expert systems and other intelligent machines can help with highly complex tasks and do so with greater efficiency, accuracy, and reliability. Hospital robots can execute routinely scheduled rounds, they are not susceptible to fatigue, boredom, burnout, or forgetfulness[ii] and can offer a welcome relief to the nursing staff, for instance.

Better Access to Care

The use of intelligent care-providing machines also extends the benefits of telehealth services by availing services to care seekers in remote geographical areas and opening access to specialty care services that may not be available in the patient's area. For instance, people who reside in areas without a sufficient population of mental healthcare practitioners can benefit from interactive virtual human care providers. Accessible anywhere and at any time, even on mobile devices, virtual care avails information about health conditions, conducts question-and-answer assessments, delivers self-care counseling and therapeutic interventions.

Improved Self-Care

By integrating data from other intelligent devices such as environmental sensors, we arables, and biofeedback devices, intelligent systems can further customize services to the clinical needs of patients. AI technologies can greatly improve self-care options for persons seeking self-treatment or health-related information. The confluence of technologies such as IoT and Cloud help fuel the capture, treatment and availability of data with the help of intelligent mobile and wearable devices to afford self-carers the possibility to monitor the progress toward individualized health goals.

Specifically in the Domain of Mental Health

Machine Perception, Affective Computing, Virtual Reality (VR) and Augmented Reality (AR) technology offer AI based platform for the assessment, treatment and long term care of mental health patients. On the other hand, directly related to the treatment of mental disorders for example, AI powered deep brain stimulation can counter depression, chronic pain, OCD, Parkinson's disease, and Tourette's syndrome, for instance[iii].

Machine Perception - Machine perception is a form of AI powered by the necessary hardware and software to recognize images, sounds, and touch, and even smell (i.e., machine olfaction) in a manner that enhances the interactivity between humans and machines. AI enriched radiology systems aid in the early detection of disease. They also improve the ability to dig further into the root cause and continue to search for subsequent abnormalities after identifying an initial one, potentially reducing the risks of misdiagnosis related to Satisfaction of search (SOS) error[iv].

Affective Computing - Affective Computing is a branch of AI that focuses on emotion recognition by machines, emotion modeling, affective user modeling, and the expression of emotions by robots and virtual agents[v]. The ability to detect, classify, and respond to the patient's (user) emotions and other stimuli can be very helpful in a therapeutic setting. Intelligent machines may be perceived as being immune to personal biases that human therapists may have. Robots may seem always friendly and always available[vi]. Care seekers may experience less anxiety when discussing intimate, private issues with a machine than they would with another person. Others may be more comfortable disclosing information to virtual humans during clinical interviews and prefer to interact with virtual humans than with medical staff[vii]. For instance, a virtual human psychotherapist could change its mannerisms (e.g., eye contact), speech dialect, use of common term, and other characteristics to match a given cultural group and thus develop and enhance rapport with a patient and improve overall communication. These virtual humans could range from online chat-bots to application specific robots.

Virtual Reality (VR) and Augmented Reality (AR) technology - Clinical assessment and treatment of various psychological disorders have used virtual reality technology for monitoring of the human reaction in certain conditions through life-like immersion in supervised situational settings. Virtual reality tools, powered by AI platforms pave the way for skills training of people with autistic spectrum disorder (Autism)[viii], and deliver treatments in the form of therapeutic computer games[ix]. Bridging virtual reality closer to the real world, Augmented Reality (AR) has provided useful applications in health care, including training and assisting surgeons in complex interventions, simulations and healthcare education. Clinical uses of AR in behavioral and mental health care include helping children with autism to learn facial emotions[x] and creating virtual stimuli that provoke anxiety in the patient's real-world environment during prolonged exposure therapy[xi].

Customizable and more affordable Mental Health Care

Intelligent care providing machines have the potential to greatly improve health outcomes among care seekers by customizing their care. These systems could be programmed with the knowledge and skills of diverse evidence-based approaches and then deliver the most appropriate the rapy or integrate different approaches based on a patient's diagnostic profile, preferences, or treatment progress. Intelligent care-providing machines may also be capable of sensitivity and adaptation to specific aspects of a patient's culture such as race/ethnicity or socioeconomic status.

Bringing the Economy of Scale of Technology to Care Delivery

In addition to improving patient outcome and quality of care, the development of intelligent machines in healthcare has the potential to bring forth significant economic benefits for healthcare providers and consumers of mental health services. Bringing the economy of scale to care delivery, software based intelligent machines can counteract the anticipated global cost of mental care, projected to exceed $6 trillion dollars by 2030 according to a report from the World Economic Forum[xii]. By speeding up decision-making processes, clinical decision support systems, supported by AI based logic can reduce demands on clinical staff time and therefore improve the overall efficiency of medical care. For example, care seekers can take self-assessments with a virtual care provider and be transferred, if necessary, to full therapy with a human caregiver.

What Could Be Next?

AI is bringing about a paradigm shift for behavioral and mental healthcare. No longer will knowledge and skills of the medical professional be limited to the physician, psychologist, counselor, social worker, or other professionals; the knowledge and skills will be built into intelligent machines that we will interact with. Psychologists and other mental healthcare professionals can assist system developers by providing the theoretical and practical expertise of implementing evidence-based treatments and therapeutic approaches into these technologies. They can potentially work together to address practical mental healthcare ethics requirements of empathy and beneficence.

The value proposition of AI use in healthcare is the prospect of designing patient-specific care. The greatest challenge to AI in these healthcare domains is in ensuring their adoption in daily clinical practice. Inviting user participation (patients) in the co-creation of solutions is essential when planning the design and implementation of successful AI based technologies[xiii].

In closing, virtual humans and robots are being improved in their capability to recognize, respond to, and express emotions. However, the integration of AI, robotics and smart machines, is yet to fully compete with the warmth of human presence. The benefits of basic human physical presence and contact, such as shaking hands before and after a session with a patient, placing a hand on the shoulder of a person who is overcome with grief, or handing a patient a tissue to dry his tears, are still irreplaceable.

Will simulated acts of empathy and benevolent kindness be experienced as analogous to the real thing? Would science reach a point where data and decision making surpass the need for the human touch? How would this affect the quality of mental health? These issues require further study, as we continue to develop intelligent care machines.

i- Luxton, D. D. (2016). An introduction to artificial intelligence in behavioral and mental health care. In Artificial intelligence in behavioral and mental health care (pp. 1-26). Academic Press.
ii- Luxton, D. D. (2014). Recommendations for the ethical use and design of artificial intelligent care providers. Artificial Intelligence in Medicine, 62(1), 110. Available from: http://dx.doi.org/10.1016/j.artmed.2014.06.004.
iii- Williams, N. R., &Okun, M. S. (2013). Deep brain stimulation (DBS) at the interface of neurology and psychiatry. Journal of Clinical Investigation, 123(11), 4546/4556. Available from: http://dx.doi.org/10.1172/JCI68341.
iv- Kim, Y. W., & Mansfield, L. T. (2014). Fool me twice: delayed diagnoses in radiology with emphasis on perpetuated errors. American journal of roentgenology, 202(3), 465-470.
v- Picard, R. (1997). Affective computing. Cambridge, MA: MIT Press.
vi- Bickmore, T. W., Mitchell, S. E., Jack, B. W., Paasche-Orlow, M. K., Pfeifer, L. M., & O'Donnell, J. (2010). Response to a relational agent by hospital patients with depressive symptoms. Interacting with Computers, 22(4), 289-298.
vii- Gratch, J., Wang, N., Gerten, J., Fast, E., & Duffy, R. (2007). Creating rapport with virtual agents. In C. Pelachaud, et al. (Eds.), Intelligent virtual agents (pp. 125-138). Springer: Berlin, Heidelberg.
viii- https://www.spectrumnews.org/features/deep-dive/virtual-reality-transforming-autism-studies/
ix- Hudlicka, E. (2016). Virtual affective agents and therapeutic games. In Artificial Intelligence in Behavioral and Mental Health Care (pp. 81-115). Academic Press.
x- Kandalaft, M. R., Didehbani, N., Krawczyk, D. C., Allen, T., & Chapman, S. B. (2013). Virtual reality social skills training for young adults with high-functioning Autism. Journal of Autism and Developmental Disorders, 43, 3444.
xi- ChicchiGiglioli, I. A., Pallavicini, F., Pedroli, E., Serino, S., & Riva, G. (2015). Augmented reality: A brand new challenge for the assessment and treatment of psychological disorders. Computational and Mathematical Methods in Medicine.
xii-www3.weforum.org/docs/WEF_Harvard_HE_GlobalEconomicBurdenNonCommunicableDiseases_2011.pdf
xiii- Davenport, T., &Kalakota, R. (2019). The potential for artificial intelligence in healthcare. Future healthcare journal, 6(2), 94–98. doi:10.7861/futurehosp.6-2-94

What Should We Know about Left Ventricular Assist Device?

Hamdan R, MD. MSc
Beirut Cardiac Institute,
Rassoul Aazam Hospital

Patients with advanced heart failure comprise an estimated 1% to 10% of the overall heart failure population, and the prevalence is increasing due to the growing number of patients with heart failure and their better treatment and survival. End stage heart failure remains a high cause of mortality and morbidity worldwide. Patients who are refractory to medical therapy and or cardiac resynchronization should be assessed for ventricular assist device eligibility. The Left Ventricle Assist Device (LVAD) was first developed in the early 1960s by DeBakey. The timing of implantation is the cornerstone and the key of success of Left Ventricular Assist Devices (LVAD) therapy. Long-term support with LVAD in patients with advanced heart failure hassurvival benefits and improves quality of life compared with conventional treatments.

Originally considered only as a lifesaving therapy for patients who were ineligible for heart transplantation, the rate of long-term MCS devices implanted for Destination Therapy (DT) is increasing. This growth is due to a growing shortage of donor hearts, increasing numbers of advanced heart failure patients, and continuous improvements in MCS technologies and survival rates.

Patients eligible for LVAD are patients with >2 months of severe symptoms despite –optimal medical and device therapy and more than one of the following:

- LVEF <25% and, if measured, peak VO2 <12 mL/kg/min.
- ≥3 HF hospitalizations in previous 12 months without an obvious precipitating cause.
- Dependence on i.v. inotropic therapy.
- Progressive end-organ dysfunction (worsening renal and/or hepatic function) due to reduced perfusion and not inadequate ventricular filling pressure (PCWP ≥20mmHg and SBP ≤80–90 mmHg or CI ≤2 L/min/m2).
- Absence of severe right ventricular dysfunction together with severetricuspid regurgitation.

Many challenges are encountered by physicians in the LVAD field, mostly the lack of knowledge and awareness among the peers and the resulting lack of or delay in patient's referral for VAD. Added to this, is the patient reticence for this therapy. In Lebanon on top of these issues, we have special obstacles that slow the progression of this technique, mainly:

1. Financial issues
2. Organ donation shortage
3. Social issue

Despite the obstacles we are facing we could establish an LVAD program, since 2010, we have implanted more than 80 pumps and we are glad to report a 2-year survival of 80%, similar to the latest survival results reported in the first IMACS registry.

In addition, we had the chance to witness full left ventricular function recovery in 2 of our patients, both had per partum cardiomyopathy, and after a meticulous weaning protocol, we performed for the first time in the Middle East LVAD pump explantation for both patients, and both of the are currently stable, 2 and 3 years post LVAD removal.

Finally, LVAD therapy in Lebanon remains a success story despite the odds. Continuous effort is required to stimulate the government to cover assist device surgery, to encourage organ donation, and to increase awareness about device therapy.

References

1. -2016 ESC Guidelines for acute and chronic heart failure. Ponikowski et al, EHJ 2016.
2. Advanced heart failure: a position statement of the Heart Failure Association of the European Society of Cardiology. Crespo-Leiro et al, EJHF 2018.
3. Prevention of right heart failure after left ventricular assist device implantation by Phosphodiesterase 5 Inhibitor. Hamdan et al. Artficial organs, 2014.
4. Challenges in Assist Devices Therapy in the Middle East. Hamdan et al, Artif Organs, 2017.
5. -First Annual IMACS Report: A global International Society for Heart and Lung Transplantation Registry for Mechanical Circulatory Support. Kirklin et al, HJLT, 2016.