Healthcare of the Future 2022
T. Bürkle et al. (Eds.)

doi:10.3233/SHTI220322

The Digital Transformation of Mental Health Care and Psychotherapy – A Market and Research Maturity Analysis

Alexander M. SCHMID[a,1] and Mascha KURPICZ-BRIKI[b]
[a] *Digital Technology Management, Bern University of Applied Sciences, Bern, CH*
[b] *Applied Machine Intelligence, Bern University of Applied Sciences, Biel, CH*

Abstract. Digital technology trends for mental health, instantiated with only emerging use cases or already established applications, offer significant potential to improve clinical therapy and care. In this paper, we identify five major trends, mHealth/eHealth, telehealth, artificial intelligence (AI), big data, and biosensors/wearables; describe seven specific technology use cases for mental health care and psychotherapy; and provide an overview of their maturity in practice.

Keywords. augmented intelligence, blended therapy, digital mental health, digital technology use cases, transformation, technology trends

1. Introduction

Digital transformation of mental health brings new opportunities and challenges to the sector. Emerging digital technology applications and use cases promise new treatments, diagnostic means, and management capabilities for mental disorders.

The evolution of digital technologies has the potential to reduce the prevalence of mental health disorders, for both individuals and populations as a whole [1], and to disrupt health care systems and their related policy-making efforts around the globe [2]. However, the speed of innovation adoption in the highly regulated sector of mental health care and psychotherapy is slow compared to the fast and fluctuant technological progress.

In this study, we investigate what technological trends and applications are emerging and assess their associated levels of market and research maturity. We aim to answer the following research questions: a) Which *major digital technology trends* impact mental health interventions?, b) Which *exemplary use cases* are available for the use of digital technologies in a clinical setting?, and c) What is the *maturity of evidence and adoption* for the efficacy of available digital technology products/services?

We have identified five major technology trends from technology studies and research in general healthcare with particular relevance for mental health [3–5]: mobile and electronic mental health (*mHealth/eHealth*), *telehealth*, *artificial intelligence (AI)*, *big data*, and *biosensors/wearables*. Table 1 characterizes those trends in detail and outlines their transformative potential for mental health care and psychotherapy. Trends in digital technology innovation are hardly fully discernible from one other, as they are

[1]Correspondence: Alexander M. Schmid, Bern University of Applied Sciences, Brückenstr. 73, CH-3005 Bern, Switzerland; E-mail: alexander.schmid@bfh.ch.

often intertwined with varying degrees of progress elements. Categorizations therefore can only be tentative.

Based on our investigations, we describe exemplary use cases for these technology trends and propose a map to illustrate their market and research maturity. We contribute an overview of use cases and assess their maturity, informing stakeholders – including mental health professionals, researchers, entrepreneurs, and patients – in technology-adoption decisions and policy-making.

2. Research Design

This report compiles the findings from a pragmatic, exploratory, qualitative multimethod inquiry. During the data collection and analysis process, we followed a semi-structured approach. We gathered intelligence from market reports; searched literature databases from fields such as healthcare, information systems research, medical informatics, and computer science; and conducted interviews. For the data analysis, we iteratively aggregated the artifacts from each of the three data collection streams and synthesized the key findings into our results, as documented herein.

We interviewed 21 stakeholders of mental health care transformation using a semi-structured protocol that covered five main themes: i) *technology trends*, ii) *use cases*, iii) *economic and regulatory developments* in the industry, iv) *state of research and practice* in digital mental health, and the v) *impacts of digitalization on therapeutic practices and institutions*. We documented the interviews with field notes.

In the market research stream, we took a technographic approach. We focused on specific segments of the global market, including diagnostics; behavioral mental health; and IT for therapy, care, and treatment. Based on case studies, use case descriptions, technology trend monitors, and the observation of mental health tech startup pitches, we synthesized vignettes of digital *technology in use* in the given context.

Furthermore, we conducted an exploratory literature research about two core topics: i) verification of digital technologies in therapy and self-help applications, and ii) AI technologies in diagnostics.

Table 1. Digital Technology Trends with Transformative Potential for Mental Health Care and Psychotherapy

Name: Description	Transformative Potential
AI: The use of algorithms for the intelligible solution of complex decision problems. Computers can efficiently and accurately analyze various data formats, including images, videos, audio, text, and statistics. These algorithmic analyses enable machine learning and the synthesis of models for correlations in the data and the prediction of conditions. Accordingly, the trend is accelerated through data accruing from *mHealth/eHealth*, *bio-sensors*, and *big data*.	Evidence-based decision-making in mental health care can be drastically strengthened through complementary or automated data analyses with computers. This trend transforms mental health because it enables new and more effective means of diagnosis (early detection and accuracy), prognosis (reference comparison), and treatment (tailoring), both at the individual and whole population levels [6,7]. The findings gained through AI research on mental health data and management can also inform better policy-making for health systems.
Big Data: The analysis of large data sets that are too complex to be handled manually or with traditional software. Sources encompass clinical, biological, administrative, or imaging data. It closely integrates with *AI*, as large data sets are a prerequisite for machine learning.	An important and growing source for mental health data is the electronic health record (EHR). The trend promises unprecedented potential for scientific exploration; descriptive observation; hypothesis generation; and predictions in clinical, research, and mental health management [8,9].

Biosensors/Wearables: Analytical devices that track physiological, behavioral, or biochemical body signals. Sensors can be integrated into wearables, that is, devices worn on the body (e.g., as extensions to phones or watches, or in clothes). The accumulated information fuels *big data* and *AI* and integrates with *mHealth*.	Sensors allow the identification of behaviors/conditions as consequences of underlying physiological alterations related to mental health disorders [10]. This trend transforms mental health by making continuous monitoring of patients and medical states possible. Data provide unprecedented insights for research and make therapeutic just-in-time/tailored interventions possible.
mHealth/eHealth: The delivery of mental health resources and services (information, treatment, management, etc.) by digital means via the internet using a variety of devices, including smartphones, tablets or personal computers, and remote monitoring devices. *mHealth* feeds into *AI* and improves accessibility to services, tailoring, adherence, and the flexibility of all parties [11].	Patients get broad access to resources and services, including information and therapy plans, fostering self-help. Devices and apps continuously generate data for research, diagnosis, and customized treatment, which enables monitoring and connections with peers, therapists, and care professionals. Offerings become more scalable than on-site, and in-person resources/ services, fostering patient autonomy with complements to traditional patient–therapist relationships.
Telehealth: The remote delivery of clinical and non-clinical mental health services, via audio, video, or text. It can be synchronous or asynchronous. Telehealth has been established for decades but has become considerably more versatile with the diffusion of the internet, including e-mail, smartphones, and video-chat systems. Telehealth closely blends with *mHealth/eHealth*.	Digital devices mediate the relationship between therapists and patients, allowing decentralized service provisioning. Through the developments in *mHealth/ eHealth*, *telehealth* often blends into web and mobile therapy applications and care management platforms. It decouples service provisioning from geographical restrictions, simplifies the match-making of patients with therapists and care workers, and offers important escalation pathways for *mHealth/eHealth* treatments.

3. Results

3.1. Digitally-Mediated Provisioning of Mental Health Care and Therapy

Use cases (UC) for *mHealth/eHealth* applications have gained considerable attention among the general public in recent years. Larger, mostly US-based companies such as BetterHelp, Talkspace, and Ginger offer full-service, online, and app-based mental health care services (**UC1**). Offerings encompass self-help programs and monitoring functionalities as well as *telehealth* functionalities, including peer support, guided therapy through professional coaches, or direct interaction with licensed therapists. In Europe, smaller companies, such as Minddistrict, GAIA, Selfapy, and the like, offer similar services, but these are mostly focused only on specific diagnoses (**UC2**). Such offerings are provided through smartphone applications via app stores or other online platforms.

Many *mHealth/eHealth* and *telehealth* applications are backed by academic evidence indicating their efficacy for the treatment of various disorders [e.g., 12], making them candidates for inclusion in clinical guidelines [13]. Accordingly, and although the process is relatively slow, regulators in Western countries are certifying a growing number of such applications as medical devices, rendering them eligible to be prescribed and expenses for their use to be covered by health insurers [14].[2]

Beyond treatment and therapy, *mHealth/eHealth* and *telehealth* applications are also popular for patient management, including health data management, the coordination of treatment pathways in clinics, or recovery journeys in general (**UC3**). Applications can

[2] Germany, for example, lists *mHealth/eHealth* and *telehealth* applications that are treated as certified medical devices (Digitale Gesundheitsanwendungen DiGA) in a web catalogue: https://diga.bfarm.de/de/verzeichnis?category=%5B%2277%22%5D.

be used for the management of both inpatients and outpatients [e.g., 15]. While such use cases do not require certification because they do not include therapeutic elements, they are an important element of integrated mental health care and therapy. Such applications can be used to store and manage EHR, therapy plans, and so on. Those functionalities allow for seamless integration with UC1 or UC2 applications and feed into the trend of *big data*.

3.2. Therapy Support and Self-Help Using Chatbots

Chatbots are computer programs that allow patients to interact with applications. They can address different purposes, such as therapy, training, and screening, and can be differentiated by their rule-based or machine learning approaches. A recent survey showed that most chatbots are rule-based (**UC4**); only 4 out of 41 solutions used technologies from the field of *big data* and *AI* such as machine learning (**UC5**) [16], though they demonstrated promising results regarding the processing of human language.

In chatbot use cases based on machine learning, *AI* is used for different purposes: virtual counseling for brief alcohol interventions with a smart virtual agent [17], the Wysa chatbot supports patients' mood management [18], the Tess chatbot engages in brief conversations for mental health support [19], and SimCoach provides an empathic "virtual human" (i.e., computer-generated characters) that provides information about post-traumatic stress disorder (PTSD) and depression to veterans [20].

Rule-based chatbots (UC5) can be seen as an extension of UC2. However, transition and overlap between UC5 and UC4 are continuous (e.g., such as with Woebot).

3.3. Diagnostics with Natural Language Processing

In the field of natural language processing, different works have investigated how social media posts or online support forums (OSF) can be used to detect mental health disorders or syndromes (**UC6**). A recent survey identified 29 studies investigating depression detection in OSFs [21]. A survey from 2017 reviewed mental illness detection methods on social media [22] and showed that mentally ill users were distinguishable from the control group and identifiable based on screening surveys, their public sharing of their diagnosis, or by their membership in an online forum.

In recent years, this subject has been further explored (e.g., to connect social media data to offline depression patients [23]). While these technologies could be valuable for clinical practitioners, scant research exists in the field of connecting these innovative technologies to clinical data and/or clinical trials. One first attempt to use interview data from burnout patients to train a machine learning model to detect burnout delivered promising results [24].

3.4. Condition Monitoring and Diagnosis Support through Wearable Sensors

The analysis of data generated by *biosensor/wearable* devices provides wide-ranging insights into mental health indicators such as emotions, mood states, stress, activity levels, and the like. In addition to wearable sensors, the use of smartphones has spread rapidly in the last decade, making their sensors—e.g., accelerometers, gyroscopes, thermometers, microphones, cameras, GPS, etc.—useable for tracking not only physiological and behavioral but also environmental parameters [10]. Through these capabilities, such use cases may integrate with UC2.

Coupled with the relevant analytical capabilities, such as those provided by *AI* and *big data* applications, use cases of *biosensors* and *wearables* serve to detect and monitor mental disorders and provide complementary insights into self-report instruments (**UC7**). For example, the unobtrusive measurement of activities of daily living and social rhythm, and even voice signals detected through sensors, can inform health care providers about the state of patients' chronic diseases, including depressive symptoms or bipolar disorders [e.g., 25–27]. Further studies suggest accurate monitoring opportunities for stress and anxiety, schizophrenia, and PTSD [10].

4. Discussion and Conclusion

Along with the emergence of digital technology use cases and evolving evidence for the effectiveness of their application in mental health care and therapy, bold promises are made while reservations linger that such applications might replace therapists or care workers. However, as appealing automation might appear from a naïve economic and techno-optimistic stance, the findings of our maturity analysis suggest that this scenario is unlikely to unfold.

According to the primary and secondary evidence we studied, a more realistic scenario for maximal diagnosis and treatment effectiveness and efficiency is the blending of human capabilities with digital technology application offerings, so-called *augmented intelligence*. Our findings also suggest that the use cases for these blended therapies and care applications vary significantly in their research and market maturity. While use cases of *mHealth/eHealth* and *telehealth* exhibit mature evidence for their effectiveness and certified market offerings, use cases of *AI*, *big data*, and similar applications are only now emerging technology trends, at most in a stage with promising experimental evidence (see Figure 1).

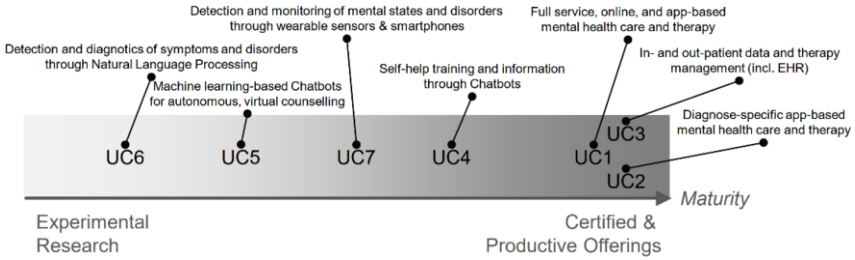

Figure 1. Maturity levels of the described digital technology use cases (UC1–7).

Our research provides an overview of the state of innovation for the application of digital technologies in mental health. Decision- and policy-makers should carefully observe the emerging evidence and offerings to continuously harvest the potential of these digital technology use cases and make them available for public use.

Acknowledgments

We are thankful to our interviewees. Furthermore, we acknowledge the valuable contribution of Dr. Markus Wyss to the data collection and selected parts of the analysis.

References

[1] Taylor CB, et al. Using Digital Technology to Reduce the Prevalence of Mental Health Disorders in Populations: Time for a New Approach. J Med Internet Res. 2020;22(7):e17493.
[2] Ben-Zeev D. The Digital Mental Health Genie Is Out of the Bottle. PS. 2020;71(12):1212-1213.
[3] Tailor K, The Patient Revolution: How Big Data and Analytics Are Transforming the Health Care Experience. Hoboken, NJ: John Wiley & Sons; 2016.
[4] Kim YK, editor. Frontiers in Psychiatry: Advances in Experimental Medicine and Biology. Singapore: Springer; 2019.
[5] Copeland B, Raynor M, Shah S. Top 10 health care innovations: Achieving more for less. deloitte.com/content/dam/Deloitte/us/Documents/life-sciences-health-care/us-lshc-top-ten-health-care-innovations.pdf [cited 2017 January 31].
[6] Fakhoury M. Artificial Intelligence in Psychiatry. In: Kim YK, editor. Frontiers in Psychiatry: Advances in Experimental Medicine and Biology. Singapore: Springer; 2019. p. 119-125.
[7] Ebert DD, Harrer M, Apolinário-Hagen J, Baumeister H. Digital Interventions for Mental Disorders: Key Features, Efficacy, and Potential for Artificial Intelligence Applications. In: Kim YK, editor. Frontiers in Psychiatry: Advances in Experimental Medicine and Biology. Singapore: Springer; 2019. p. 583-627.
[8] Monteith S, Glenn T, Geddes J, Bauer M. Big data are coming to psychiatry: a general introduction. Int J Bipolar Disord. 2015;3(1):21.
[9] Ressler KJ, Williams LM. Big data in psychiatry: multiomics, neuroimaging, computational modeling, and digital phenotyping. Neuropsychopharmacology. 2021;46(1):1-2.
[10] Sheikh M, Qassem M, Kyriacou PA. Wearable, Environmental, and Smartphone-Based Passive Sensing for Mental Health Monitoring. Front Digit Health. 2021;3:662811.
[11] Hollis C, et al. Technological innovations in mental healthcare: harnessing the digital revolution. The British Journal of Psychiatry. 2015;206(4):263-265.
[12] Berger T, et al. Evaluating an e-mental health program ("deprexis") as adjunctive treatment tool in psychotherapy for depression: Results of a pragmatic randomized controlled trial. J Affect Disord. 2018;227:455-462.
[13] Aitken M, Nass D. Digital Health Trends 2021: Innovation, Evidence, Regulation, and Adoption. iqvia.com/-/media/iqvia/pdfs/institute-reports/digital-health-trends-2021/iqvia-institute-digital-health-trends-2021.pdf [cited 2021 August 17].
[14] Weir K. The age of digital interventions. Monitor on Psychology. 2021 Oct 1;52:22.
[15] Rodriguez-Villa E, et al. The digital clinic: Implementing technology and augmenting care for mental health. Gen Hosp Psychiatry. 2020;66:59-66.
[16] Abd-Alrazaq AA, et al. An overview of the features of chatbots in mental health: A scoping review. Int J Med Inform. 2019;132:103978.
[17] Yasavur U, Lisetti C, Rishe N. Let's talk! speaking virtual counselor offers you a brief intervention. J Multimodal User Interfaces. 2014;8:381-398.
[18] Inkster B, Sarda S, Subramanian V. An Empathy-Driven, Conversational Artificial Intelligence Agent (Wysa) for Digital Mental Well-Being: Real-World Data Evaluation Mixed-Methods Study. JMIR Mhealth Uhealth. 2018;6(11):e12106.
[19] Fulmer R, et al. Using Psychological Artificial Intelligence (Tess) to Relieve Symptoms of Depression and Anxiety: Randomized Controlled Trial. JMIR Ment Health. 2018;5(4):e64.
[20] Swartout W, et al. Virtual Humans for Learning. AIMag. 2014;34:13-30.
[21] Nanomi Arachchige IA, Sandanapitchai P, Weerasinghe R. Investigating Machine Learning & Natural Language Processing Techniques Applied for Predicting Depression Disorder from Online Support Forums: A Systematic Literature Review. Information. 2021;12(11):444.
[22] Guntuku SC, et al. Detecting depression and mental illness on social media: an integrative review. Current Opinion in Behavioral Sciences. 2017;18:43-49.
[23] Ophir Y, Asterhan CS, Schwarz BB. The digital footprints of adolescent depression, social rejection and victimization of bullying on Facebook. Computers in Human Behavior. 2019;91:62-71.
[24] Nath S, Kurpicz-Briki M. BurnoutWords - Detecting Burnout for a Clinical Setting. In: Wyld D, Nagamalai D, editors. Proceedings of the 10th International Conference on Soft Computing, Artificial Intelligence and Applications (SCAI 2021); 2021 Nov 20-21; Zurich, Switzerland. Chennai: AIRCC Publishing; 2021. p. 177-191.
[25] Kim JY, Liu N, Tan HX, Chu CH. Unobtrusive Monitoring to Detect Depression for Elderly With Chronic Illnesses. IEEE Sensors Journal. 2017;17:5694-5704.
[26] Matthews M, et al. Development and Evaluation of a Smartphone-Based Measure of Social Rhythms for Bipolar Disorder. Assessment. 2016;23(4):472-483.
[27] Tokuno S. Pathophysiological Voice Analysis for Diagnosis and Monitoring of Depression. In: Kim YK, editor. Understanding Depression. Singapore: Springer; 2018. p. 83-95.