

Clinical Application of Digital Technologies in Adolescent and Young Adult Oncology Supportive Care

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Introduction

THE CORONAVIRUS DISEASE 2019 (COVID-19) pandemic has illustrated the advantages of using digital health technologies, such as telemedicine, to improve accessibility to both medical and psychosocial care. The use of such technologies can significantly impact adolescent and young adult (AYA) cancer patients' care by improving adherence, personalizing care, measuring health perception, and improving disparities. The population's perception of the utility of digital technologies is not concordant with that of their health care providers.¹ This has created a unique situation in which patients' experiences with a potential class of therapeutic interventions are more comprehensive than that of their providers. Providers are frequently unaware of how digital technology is used by patients, impacts their perceptions of health, and facilitates adherence to therapies.² Hereunder, we seek to highlight the digital technologies with the most potential to improve AYA supportive care based on initial data. Furthermore, we illustrate the need for further research of these technologies.

Methods

A literature search for existing articles within PubMed, Medline, Google Scholar, Google, Yahoo, and Bing was conducted in April of 2020. Search terms included but were not limited to "digital health," "digital technology," "pediatric," "adolescents," "young adult," and "oncology." Given the increased prevalence of telehealth articles in the setting of the COVID-19 pandemic, an extenuating circumstance, these were excluded from the literature review. The remaining articles pertinent to AYA oncology were classified into the three broad categories explored hereunder, with a summary of the most impactful and AYA-relevant articles described.

Extended reality

Virtual reality (VR), augmented reality, and mixed reality exist on a continuum of immersion that allows users to be displaced to a completely new digital environment, or to combine components of the real and digital worlds (Fig. 1). This is accomplished by using a heads-up display or mobile device (Fig. 2). Of these, VR has, thus far, been most thor-

oughly studied in the clinical setting. With ~171 million users worldwide, VR technology has an adoption rate that outpaces early adoption of personal computers, the internet, and mobile phones.^{3,4} VR uses a combination of body tracking sensors and display headsets to immerse the user in an artificial environment. It allows for complete immersion, allowing patients to entirely block out the sights and sounds of their external environment.⁵

Clinically, most medical applications of VR focus on decreasing pain or other noxious stimuli.⁵ Although the true mechanisms by which VR reduces pain perception remain unclear, Hoffman et al. used functional magnetic resonance imaging to show that VR caused a statistically significant reduction in pain-related neural activity in multiple regions of the brain, including the anterior cingulate cortex and the thalamus.⁶ A pilot study with 59 pediatric oncology patients found that VR reduced pain from subcutaneous venous port access, including decreases in heart rate and pain, as measured by the visual analogue scale.⁷ Another pilot study looked at the use of VR's distraction potential during chemotherapy infusions. In 11 patients aged 10–17 years, 82% found that VR distracted them from the fact they were receiving chemotherapy.⁸

VR is being further explored for other health care applications including education, social interaction augmentation, and as an adjunct to cognitive-based therapy and other psychiatric treatments.^{9,10} For patients with physical disabilities or social anxieties that prevent them from participating in support groups, VR provides the opportunity to connect with others and build strong social support networks.¹¹ During situations requiring quarantine or isolation, such as the COVID-19 pandemic or bone marrow transplant, VR has been seen as a way to cope with the deleterious effects of prolonged isolation.¹²

Social media

Social media has become an important outlet for AYA patients with cancer to exchange ideas and support.¹³ Health professionals approach their patients' use of social media for health communication and information with mixed reactions, specifically due to concerns of scientific accuracy and exposure of their clinical decision making to public scrutiny.¹³ A qualitative study by Gage-Bouchard et al. found that within 15,852 cancer-related posts on various social media

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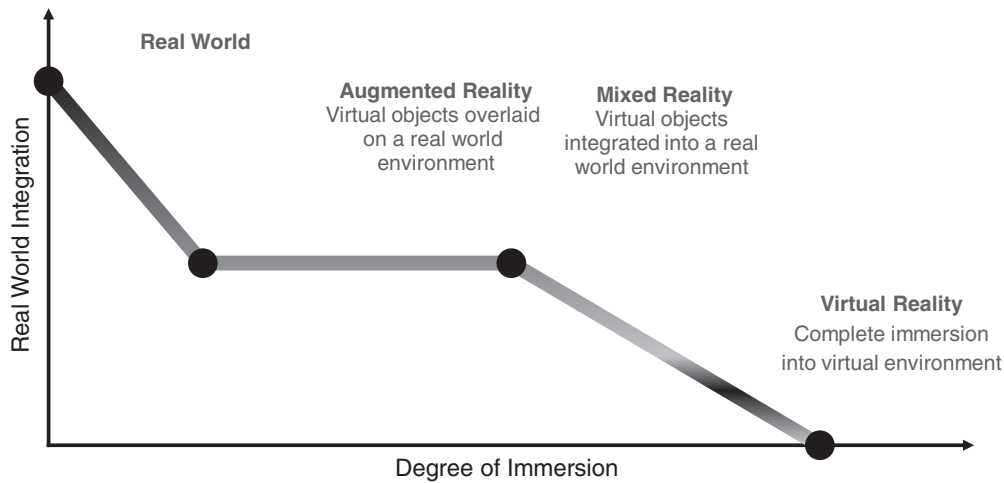


FIG. 1. Comparison of the differences between virtual, augmented, and mixed reality.

platforms, types of information included treatment protocols, health services usage, side effects, and complementary therapies.¹³ Social media is a particularly appealing communication modality in this population as AYAs do not readily participate in traditional psychosocial interventions.¹⁴ In addition to the peer-to-peer use of social media, there are AYA-focused social media accounts specifically aimed at this patient population. One Instagram[®] account, The Cancer Patient (@thecancerpatient), is a satirical approach to the challenges that come with having cancer and has >52,000 followers as of print.

Formal evaluation of these and similar resources includes a study done by Beaupin et al. investigating the feasibility of a novel concept called “photographs of meaning” within the AYA oncology population. Participants utilized a social media platform called PixStori to anonymously post on weekly themes chosen by the study coordinator. Other users anonymously viewed and commented on these posts. All 13 participants felt they would recommend the intervention to peers.¹⁴ Another study involved developing a social media site called LIFECommunity for AYA cancer survivors to

create blogs and share information with peers.¹⁵ Participants with less of an “in-person” support network and those with strong pre-existing connections with other survivors used this resource most, concluding that LIFECommunity potentially filled a void in the participants’ support system.¹⁵ Despite these perceived benefits, concerns remain about the impact of social media on children and young adults.¹⁶

Compliance enhancement technology

Recently, wearable devices and mobile phone applications promoting health maintenance have surged in popularity.¹⁷ A study done by Yurkiewicz et al. provided iPads[®] and synced Fitbit[®] fitness trackers to AYA patients at time of diagnosis.¹⁸ Seventy-nine percent of participants reported a subjective increase in physical activity and health-related quality of life. Although there were some drawbacks to the study, including patients’ use of the iPads for more sedentary activities, the step tracker did give motivation to increase physical activity.¹⁸

Oral medication compliance is another field in which technology-driven interventions are being explored through digital health applications and electronic monitoring caps.¹⁷ Smart bottles such as Nomi[®], SMRxT[®], and Adheretech[®] provide increased reliability of measuring medication adherence.¹⁹ Oral medication nonadherence in the AYA population ranges between 27% and 60% and has been attributed to forgetfulness, a state of significant transition, and changing insurance status.^{20,21} A pilot study done with 23 AYA patients using a smartphone application to improve adherence to oral medications found that >50% of patients took their medications with the reminders.²¹

A recent study evaluated an application called “Pain Squad”—a mobile health application that “gamified” pain assessment and management in the AYA population. A reward system encouraged management compliance, and found 81% compliance among 18 patients.²² An improved version of the application recommended management techniques based on a standardized algorithm when patients felt pain, with an email alert sent to an oncology trained nurse if an adolescent reported sustained pain.²² The study found statistically significant decreases in pain and



FIG. 2. Heads-up display and handset used in virtual reality.

improvement in quality-of-life measures.²² These studies show the feasibility of implementing real-time monitoring systems in a remote setting.

Discussion

The AYA population's agility with technology has brought about significant positive change. It has empowered them to find like-minded communities online and new ways to gain knowledge.²³ They utilize technology to communicate and are more receptive to the use of technology to improve their health.²³ The aforementioned technologies contain a wealth of potential that can and should be utilized by providers and researchers alike to engage AYA patients in their health care.

There are multiple pilot studies in the literature that explore digital technologies with the potential to improve the care of AYA patients. There is, however, an extreme paucity of research beyond the proof-of-concept stage. Roadblocks include providers' general skepticism and difficulties implementing these modalities due to a lack of comfort with the technologies, as well as concerns regarding privacy, confidentiality, and professionalism.¹⁶

Digital health is quickly evolving, requiring the academic community to adopt new ways to explore its potential in a timely manner.² Although the COVID-19 pandemic has accelerated the use of telemedicine, the aforementioned technologies have only been explored in a limited manner and have the potential to be impactfully incorporated with existing digital health platforms.²⁴ Birckhead et al. have proposed a framework to develop and implement large scale clinical trials utilizing VR, but this framework could potentially be broadened to include other technologies.²⁵ Similarly, the Italian Pediatric Hematology and Oncology Association created a multidisciplinary working group to develop guidelines addressing the proper use of social media by health care professionals, particularly when interacting with AYA patients. Significant emphasis was placed on the use of these platforms to supplement in-person interactions while maintaining professional boundaries and awareness of patient confidentiality issues.¹⁶

AYAs are keen adopters of new technologies, providing an even greater impetus to explore the impact of digital health on this population. This article explores the three most studied psycho-oncology digital technology categories based on literature review. The care of AYA oncology patients could be improved with further investigation into these modalities on a larger scale with greater provider understanding and incorporation of the AYA perspective.

Authors' Contribution

All authors have contributed to the article in significant ways, have reviewed, and agreed upon the article content.

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