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Use of eHealth for HIV Medical Education: a Narrative Review

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Abstract

Purpose of Review The complexity of HIV care and its expanding clinical workforce has created a need for new distance learning models to deliver medical education. We conducted a narrative review to assess the acceptability and effectiveness of recent eHealth HIV education interventions supporting HIV healthcare providers.

Recent Findings Evidence from 24 articles revealed that synchronous (real time), asynchronous (any time), and hybrid (combination) models of eHealth education are feasible and acceptable. Only two interventions (one asynchronous, one hybrid) of 19 included in the review utilized a randomized controlled design. Some studies showed improvement in confidence and perceived quality of case management, but few studies were designed to demonstrate impact.

Summary Successful eHealth education interventions require a thorough understanding of the target community's capacity and needs. Both synchronous and asynchronous strategies appear acceptable and potentially effective, but more studies are needed to assess impact on knowledge and practices to determine the most effective delivery models.

Keywords eHealth · HIV · Medical education · CME · Continuing medical education · Narrative review

Introduction

HIV/AIDS persists as one of the most significant global public health challenges of our time. Since the first case was diagnosed in 1981, HIV-related illness has claimed almost 33 million lives worldwide [1]. Currently, there are approximately 38 million people living with HIV (PLWH) globally, all of whom require initiation and lifelong retention on antiretroviral therapy (ART) [1]. Through ART, HIV has become a lifelong chronic illness requiring complex medical care and treatment, including management of sometimes complex regimens to control HIV and treat or prevent opportunistic infections, particularly tuberculosis. PLWH are also at increased risk of certain cancers [2, 3], and face higher rates of liver disease, cardiovascular disease, dyslipidemia, diabetes, kidney disease, dementia, and osteoporosis as they age [4].

To be effective, HIV clinicians must be proficient in an ever-expanding range of topics as they begin providing treatment, and must engage in continuing medical education (CME) to maintain, develop, or increase their knowledge and capacity throughout their careers. However, traditional models of in-person medical education are burdensome and expensive, and the use of mid-level providers to increase the capacity of the HIV clinical workforce [5] has only increased the number of HIV clinicians who require CME. In this context, distance learning delivered over electronic platforms could be an attractive alternative to traditional models of in person CME, provided that they can be shown effective at improving knowledge among HIV clinicians. To assess this knowledge gap, we conducted a narrative review of the use of

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eHealth for training HIV medical providers. Our goals were to define the scope of eHealth CME strategies described in the literature and, where possible, to assess the strength of evidence about their effectiveness at improving knowledge of HIV clinical care.

Methods

We performed an electronic search in PubMed and Embase databases on September 10, 2020, using search terms related to remote learning (including digital learning, e-Learning, eHealth, and mHealth), HIV/AIDS, and health providers. We defined "HIV/AIDS providers" broadly to encompass doctors, nurses, medical students, community health workers, lay workers, physician's assistants, and/or midwives. Our search encompassed interventions that covered a broad continuum of medical education, including undergraduate medical training, residency training/graduate medical education, and CME/continuous education and improvement. Additional inclusion criteria were any peer-reviewed articles published on or after January 1, 2015. This cutoff was selected in light of the rapidly changing landscape of eHealth tools and our interest in capturing the most current innovations in this field. We excluded articles for which full text was not available or were systematic reviews and meta-analyses, commentaries, conference abstracts, or articles on patient interventions. There were two review stages, the preliminary title and abstract screening and the full-text article review. Two authors reviewed each article at both stages. Conflicts at all stages of the review were resolved through a discussion with all authors.

Interventions Included in the Review

Figure 1 summarizes the search and review process that resulted in the final set of articles included in the analysis. Twenty-four articles were included in this review (Table 1). Reisach and Weilemann developed recommendations for an e-Learning framework after conducting tests with community health workers in South Africa [6]. The other 23 articles represented 19 unique eHealth HIV medical education interventions: 12 interventions used solely eHealth mechanisms, whereas seven combined in-person and eHealth components. Table 2 summarizes the geographic location, target provider, intervention contents, and mode of delivery, and offers a description of the 19 unique interventions.

Training content varied according to the nature of the setting and the participant population. Nine interventions focused solely on HIV clinical management [7–16]. Three related to HIV testing and counseling [17–19]. One intervention—the mobile CME (mCME) intervention in Vietnam—was more comprehensive, addressing HIV clinical management, testing, counseling, palliative care, and comorbidities [20–22]. The remaining interventions addressed stigma in care and treatment of HIV/AIDS patients [23, 24], prevention of mother-to-child transmission [25], HIV-tuberculosis (TB) coinfection [26], and LGBTQ-sensitive HIV care. [27] One intervention, focused on global health leadership, contained a brief session on "HIV/AIDS updates" [28].

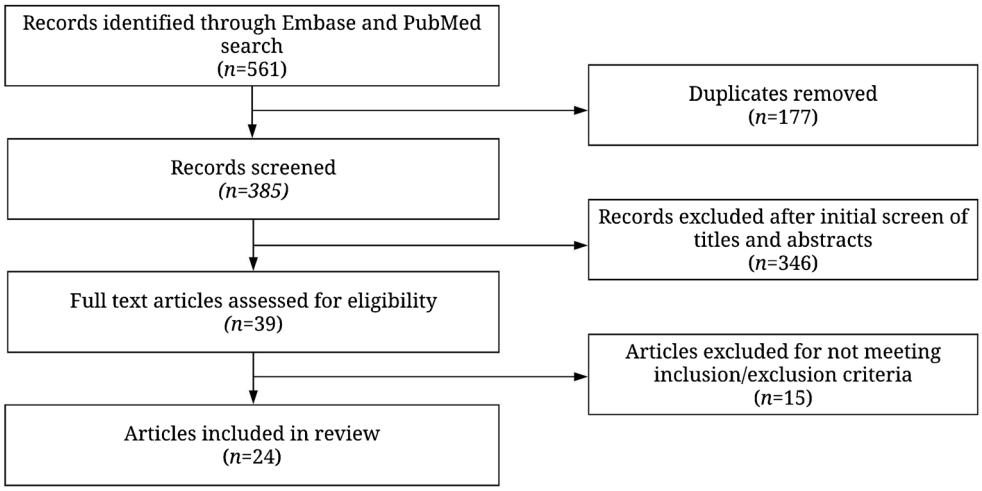
Synchronous Versus Asynchronous eHealth Medical Education

The most evident way of stratifying the different eHealth modalities was whether the learning was delivered in real time (synchronous learning); accessed independently at any time (asynchronous learning); or involved a combination of both approaches (hybrid model).

Synchronous learning models deliver remote education to all students participating at the same time, thus creating a virtual classroom. Five interventions provided live instruction over tele- or video-conference during which participants could ask questions and engage in discussions with clinical experts and with each other [9, 11–14]. Among these, the most notable model was the Extension for Community Healthcare Outcomes (ECHO), described in several articles [11, 12] and adapted in others [13]. ECHO connects community providers to both a multidisciplinary specialist team and local peer providers to create a network for clinical support and education. Tele-conferencing approaches were also described in two case studies: one delivered CME to rural providers in Haiti [14], while the other established a telecommunications platform for Italian physicians to share clinical data and discuss cases with providers in eSwatini [9].

Asynchronous learning, by contrast, does not require real-time interaction. Instead, participants can access content at a time convenient to them. Asynchronous learning strategies build on a variety of technological approaches. These include short message service (SMS) or other interventions using a messaging or chat function; downloadable course material interventions that can be viewed on a mobile device; and modules that are emailed or accessible online. Of the eight asynchronous interventions included in this review, two used SMS or WhatsApp for training purposes. WhatsApp is a free software that uses the phone's cellular or Wi-Fi capability to send and receive text messages, photos, audio, video, documents, and locations, and make voice calls over the Internet [29]. In one intervention, a WhatsApp group for discussion of clinical cases was created for doctors who had undergone training on HIV and TB co-infection [26].

The mCME 2.0 intervention in Vietnam used SMS over a 6-month period to deliver daily multiple-choice quizzes to HIV providers, provide hyperlinks to online CME courses and readings, and send regular updates on individual



Search structure
(Remote learning) AND (HIV/AIDS) AND (Health providers)

Search concepts

Remote learning	**Health providers**
Distance education	Clinicians
Distance learning	Medical Providers
MOOC	Doctors
Online learning	Nurses
Online education	Community health workers
Remote learning	Residents
Online training module*	Health personnel
Online module*	Healthcare personnel
Online course*	Health care personnel
Mobile learning	Medical staff
mLearning	Hospital personnel
E-learning	Physicians
Virtual learning	Medical professionals
Virtual education	Health care providers
Electronic learning environment	Healthcare providers
Electronic learning platform	Health care workers
Ehealth	Healthcare workers
Mhealth	Physician assistants
Electronic health	Medical students
Mobile health	Nursing students
Digital health	Physician assistants students
	Community care workers
HIV/AIDS	Lay health workers
HIV	ASHAs (Accredited Social Health Activists)
Human Immunodeficiency Virus	Lady Health Workers
Acquired Immunodeficiency Syndrome	Midwives
AIDS	Traditional Birth Assistants (TBAs)
	* = plurals included

Fig. 1 Search and review process for articles included in the analysis

performance on recent quizzes relative to peers. Together, delivery of this information was designed to encourage self-study on relevant topics to improve HIV-related knowledge [20–22].

The remaining six asynchronous interventions used modules accessible via website, email, or tablet. In the T-HIT intervention, tablets were given to health workers to share weekly educational material [25], whereas in Mozambique, tablets were used to share videos, vignettes, and case studies [18]. Four of the 19 interventions used self-paced online modules [7, 8, 15, 16] or emailed participants a new case study, questions, and relevant links to engage in self-study [30].

Hybrid models incorporate elements of synchronous and asynchronous learning into an integrated training strategy. Six interventions used a hybrid approach. For example, DriSti's in-person training sessions were complemented with a tablet-based asynchronous component [23, 24]. Four interventions used online modules as a complement to in-person training sessions [10, 19, 27, 28]. One intervention supplemented in-person classroom sessions with tablets that shared videos, case studies, and quizzes, and a WhatsApp discussion group [17].

Evidence of Effectiveness and Lessons Learned

The articles included in the review employed a variety of research designs to evaluate the interventions (see Table 1). Of the 19 articles presenting evaluation data, most (10 of 19) employed a cross-sectional design to gain feedback from participants on acceptability and utility [7, 11–13, 15–17, 20, 26, 30]. Two articles employed a quasi-experimental design to assess knowledge outcomes [18, 19], and four conducted a single-group pre-post assessment of gains in knowledge

Table 1 Articles included in review

Authors (year)	Study name	Clinical focus	Intervention type*	Study design	Key findings**
Battat et al. (2016)	The Haiti Medical Education Project	Multiple diseases, including HIV	eHealth only	Case study	*Narrative*: Successful delivery of a competency-based CME program between the USA and Haitian physicians using video-conferencing
Bertman et al. (2019)	Training in HIV Testing Services for Children and Adolescents	HIV	eHealth and in-person	Cross-sectional qualitative interviews	*Qualitative*: Positive feedback on acceptability and use of text messaging as an adjunct to training courses; useful for information seeking, support, and case discussion
Bonawitz et al. (2019)	The Mobile Continuing Medical Education Project (mCME V1.0, mCME V.2.0)	mCME v1 primary care; mCME v2 HIV	eHealth only	Cross-sectional qualitative interviews	*Qualitative*: Key lessons for design include using mixed-methods approaches to evaluate mHealth CME approaches, using an underlying behavior change theoretical framework in intervention design, having expertise in software programming, aligning educational content to a well-defined participant population, and engaging/motivating adult learners.
Ekstrand et al. (2020)	DriSti	HIV, HIV stigma	eHealth and in-person	Cluster RCT	*Quantitative*: Six-month outcomes showed significant reductions in misconceptions ($p < .001$), worry about acquiring HIV at work ($p < .001$), endorsement of coercive policies ($p < .001$), and number of situations in which providers intended to discriminate against people living with HIV ($p < .001$).
Feldacker et al. (2017)	Assessment of Online "Clinical Management for HIV" Course	HIV	eHealth only	Cross-sectional survey	*Quantitative*: Women and HCWs under age 40 were most likely to prefer learning through clinical mentorship ($p < .001$). Thirty-nine percent of respondents preferred self-paced Internet/computer-based learning over other modalities.** *Qualitative*: Online courses were appealing due to knowledge gains and format flexibility participants desired recognition of course completion and requested additional online coursework.
Frasca et al. (2019)	PrEP and HIV Prevention Curriculum	HIV and sexually transmitted infections	eHealth and in-person	Mixed-method single group pre-post study	*Quantitative*: Increased confidence and comfort in all HIV prevention topic areas, with the greatest gains in safe sex counseling for LBGTQ patients in discussing PrEP ($p < .0001$). *Qualitative*: Six of 9 interviewees post-course had applied what they learned to patient care; five indicated their learning would benefit patients.
Gill et al. (2018)	mCME v2.0	HIV	eHealth only	RCT	*Quantitative*: Intervention participants were more likely to use the CME courses (risk ratio 2.3, 95% CI 1.4–3.8, $p < .001$). Intervention participants significantly increased self-study behaviors, outperformed controls on the exam and had higher job satisfaction.
Joore et al. (2018)	Blended Educational Programme for General Practitioners' Trainers to Stimulate Proactive HIV Testing	HIV and sexually transmitted infections	eHealth and in-person	Quasi-experimental	*Quantitative*: Educational outcomes improved but there was no evidence of improvement in HIV testing behaviors among providers.**
Kim et al. (2020)			eHealth only		

Table 1 (continued)

Authors (year)	Study name	Clinical focus	Intervention type*	Study design	Key findings**
	mLearning Approach for Nurses Providing Option B+ Services	HIV, Option B+, family planning		Prospective mixed-methods study	*Quantitative*: Skill and knowledge of nurses at intervention clinics improved threefold compared with control clinics ($p = 0.04$) and nurse managers demonstrated a 9- to 10-fold improvement. *Qualitative*: Tablets are an effective and engaging learning platform, especially when paired with supportive supervision. Nurses reported this intervention was highly acceptable.
Larson Williams et al. (2019)	mCME v2.0	HIV	eHealth only	RCT	*Quantitative*: Ninety percent of participants reported that daily quizzes improved motivation to study and 83% of intervention participants felt better prepared to care for patients. Participation in online coursework was low, but those did participant found them engaging and relevant.** *Qualitative*: mCME v2.0 was found to be highly acceptable. Participant's availability to study, professional relevance of the topic area, and feedback motivated engagement in higher learning and can help explain behavior change.
Nakanjako et al. (2015)	Afya Bora Global Health Leadership Program	Leadership with an HIV module	eHealth and in-person	Case study	*Narrative*: Online modules can be used to enhance in-person learning in a variety of topics. Availability to study, professional relevance of topic area, and feedback are important motivators for engagement.
Ness et al. (2017)	MW AETC (Mountain West AIDS Education and Training Center) ECHO (Extension for Community Healthcare Outcomes)	HIV, perinatal HIV	eHealth only	Cross-sectional mixed-methods study	*Quantitative*: One hundred percent of respondents reported that presenting cases in ECHO "very much" influenced their management of the patient. Seventy-five percent reported that observing a case consultation "very much" or "somewhat" influenced management of a patient in their practice. Thirty-seven percent of providers reported that if they did not participate in ECHO they would refer their HIV-positive pregnant patients to another provider ranging from within the same office to 589 miles by plane (on average, 30-mile distance).**
Nyblade et al. (2018)	DriSti	HIV stigma	eHealth and in-person	Case study	*Narrative*: Ground intervention development in behavior change strategy. Blended learning approach facilitates better learning specific to stigma reduction. Video content should be culturally competent but developing videos locally can be a challenge.
Pizzi et al. (2015)	HARP (Health Assistance Remote Platform)	HIV	eHealth only	Case study	*Narrative*: Telemedicine platforms with minimal connectivity and software to connect healthcare workers with providers may be beneficial in resource-limited settings.
Rafferty et al. (2019)	Acute HIV Infection Training Module	HIV	eHealth only	Single group pre-post study	*Quantitative*: Significant improvement on test scores after training ($p < .0001$). Participants had difficulty understanding the utility and application of a screening algorithm to identify patients for whom acute HIV infection testing would be

Table 1 (continued)

Authors (year)	Study name	Clinical focus	Intervention type*	Study design	Key findings**
					indicated. Knowledge of acute HIV infection was poor at baseline but improved with self-directed learning.**
Reisach and Weilemann (2015)	Development of e-Learning Framework for CHWs of HOPE Cape Town	HIV	eHealth only	Case study	*Narrative*: Provide easy resources for self-study, including links. Use easy language, explanatory pictures and videos, activating tasks, and competitions. Have material available offline and in print form. Integrate learning into daily routines. Build a network of experts/consultants for mHealth learners to engage with.
Salbach et al. (2019)	Implementation Tool to Increase Awareness of a Clinical Practice Guideline to HIV Rehabilitation	HIV	eHealth only	Single group, cross-sectional interviews	*Qualitative*: Learners enjoyed concise case scenarios. Easy access to correct information and hyperlinks promoted self-study. Diverse and realistic case scenarios relevant to learner's practice are important.
Thomas et al. (2020)	Tanzania Health Information System (T-HIT)	HIV, PMTCT	eHealth only	Single group pre-post study	*Quantitative*: Significant improvement for the total survey ($p < .008$) and for questions concerning system attitude ($p < .008$). HWs in hospitals and health centers exhibited a lower initial level of acceptability but experienced a significant improvement. HWs working more than 20 km from a hospital had lower initial levels of system knowledge and acceptability than their less remote counterparts, but demonstrated improvements in knowledge and acceptability.**
Valenti et al. (2019)	Training Internal Medicine Residents to Provide Care and Treatment for HIV Patients	HIV	eHealth and in-person	Single group pre-post study	*Quantitative*: Significant increase in test scores ($P < .0001$)
Wang and Abrams (2019)	New York State HIV-HCV-STD CEI (Clinical Education Initiative)	HIV, HCV, STI	eHealth only	Cross-sectional survey	*Quantitative*: The online program successfully reached out to primary care communities. Both younger and senior providers used the online program. High-quality multimedia resources, flexibility of access, ease of use, and provision of continuing professional development credits contributed to acceptability**
Wang and Luque (2016)	New York State HIV-HCV-STD CEI (Clinical Education Initiative)	HIV, HCV, STI	eHealth only	Cross-sectional survey	*Quantitative*: Clinician evaluations were very positive overall, in particular physicians and nurse practitioners. Pharmacists and case/care managers were less satisfied with the content. Content should be tailored to address unique needs of clinicians from various disciplines.
Wao et al. (2015)	Florida/Caribbean AIDS Education Training Center (F/C AETC) Project Extension for Community Healthcare Outcomes (ECHO) Program	HIV	eHealth only	Cross-sectional survey	*Quantitative*: The three primary motivations for engaging in ECHO were gaining/updating knowledge, learning from experts, and observing/applying skills.
Wood et al. (2016)	University of Washington and MW AETC Telehealth Program	HIV	eHealth only	Cross-sectional survey	*Quantitative:* Providers most frequently sought consultant for changing ART, evaluating acute symptomatology, and managing mental health issues.** There was a significant

Table 1 (continued)

Authors (year)	Study name	Clinical focus	Intervention type*	Study design	Key findings**
					increase in self-reported confidence to provide essential elements of HIV care ($p < .05$), feeling part of community of practice and professional connection, which correlated with level of program engagement.
Woods et al. (2019)	WhatsApp HIV/TB Clinical Discussion Group	HIV, TB	eHealth only	Cross-sectional survey	*Quantitative:* Statistically significant increase in group engagement, use of group to pose questions, report new clinical insights, reference old case material, and use of peer guidance to manage cases

**Findings that are not statistically significant but relevant to practice

post-intervention [8, 10, 25, 27]. Only a few studies aimed to demonstrate efficacy using a randomized control trial (RCT): mCME [20–22] and DriSti [23, 24]. Five articles presented narrative findings from case studies describing the design [6, 9, 24] and/or delivery [9, 14, 28] of their interventions, identifying lessons learned for implementation of eHealth interventions, but offering limited generalizability. We present findings related to the interventions' effectiveness for each type of learning format according to their level of rigor.

Synchronous Learning

Our review adds to the growing evidence that providers find synchronous eHealth approaches acceptable [31, 32], particularly for community health providers in rural areas. Acceptability and utility of the five interventions that provided instruction over tele- or video-conference were demonstrated in the USA [11–13], and to a lesser extent due to their case study design, in Haiti [14] and eSwatini [9].

There is limited evidence on effectiveness of these interventions in changing knowledge, attitudes, and practices. Cross-sectional studies demonstrated mixed results. One ECHO intervention reported a null effect on improving knowledge [12], whereas another [11] demonstrated significant increases in knowledge. Some studies demonstrated increases in providers' self-reported confidence to provide essential elements of HIV care [13], improved perceived case management [11], and an increased sense of being part of a community of practice [11, 13].

Synchronous virtual learning is interactive and can be engaging for participants, while eliminating the need for travel (often costly) required by in-person medical education. However, it poses several barriers to implementation and sustainability. When instructors and participants reside in different time zones, sessions can be challenging to schedule, especially if planned on a long-term basis. Regardless of location, these models also require participants to adhere to a fixed schedule that may conflict with individuals' clinical and/or personal responsibilities.

Furthermore, as noted in the case study in eSwatini, resource-constrained settings may present additional challenges, such as ensuring the required levels of Internet bandwidth needed for strong connectivity to facilitate engagement and the security required to transfer medical records [9]. Scaling up such models can also be problematic given the technological resources required to engage participants (e.g., multiple computers and/or screens), and may be better suited to small groups.

While synchronous learning solves the problem of accessing students who may be scattered widely by geography, it does not solve the challenge of securing enough qualified teachers to deliver the online, real-time content or scheduling that suits the needs of all participants. Its value is the

Table 2 Interventions* by learning format

	Location	Providers	Mode of delivery	Intervention summary	Focus of HIV education
Synchronous					
The Haiti Medical Education Project (Battat)	Haiti	Physicians	Tele-conferencing	Competency-based CME was provided to rural physicians in Haiti in the form of lectures from experts elsewhere via teleconferencing. Participants could ask questions directly to the instructor or to colleagues.	HIV PEP/PrEP, STIs, pharmacoresistance to HIV, understanding HIV drug resistance, cognitive disorders associated with HIV and their impact on treatment of HIV
MW AETC (Mountain West AIDS Education and Training Center) ECHO (Extension for Community Healthcare Outcomes) (Ness)	USA	Community-based healthcare providers	Video-conferencing	Specialists provided longitudinal education and clinical support through video-conferencing with focused didactic lectures and real-time case consultation in which the multidisciplinary panel discusses the community providers' own cases.	HIV clinical management, perinatal HIV
HARP (Health Assistance Remote Platform) (Pizzi)	eSwatini	Rural health motivators	Video-conferencing	HARP offers healthcare remote workers (Rural Health Motivators) a multimedia tool which Italian doctors can provide information, consultations, distance learning, and transmission of scientific documents.	HIV clinical management
Florida/Caribbean AIDS Education Training Center (F/C AETC) Project Extension for Community Healthcare Outcomes (ECHO) Program (Wao)	USA, Puerto Rico, and US Virgin Islands	Healthcare providers	Tele-conferencing /video-conferencing	One-hour interactive sessions on a current HIV treatment issue and case discussion using Adobe Connect Pro, a live video-based Internet-conference technology, and/or a telephone conference line	HIV clinical management
University of Washington and MW AETC Telehealth Program (Wood)	USA	Healthcare providers	Online repository and video--conferencing	Weekly interactive video session. 15-min didactic HIV update followed by a brief question and answer period, and then 1 h of case consultations and discussion. After each session, participants who presented a clinical case receive written summaries of the panel's recommendations and key points from discussion. All participants receive a follow-up email after each session with links to resources or studies highlighted during the session. Participants can also access the specialty panel between sessions by email or telephone for urgent clinical questions.	HIV clinical management
Asynchronous					
Assessment of Online "Clinical Management for HIV" Course (Feldacker)	Thirteen sub-Saha-ran African countries	Healthcare workers	Online modules	e-learning course on clinical management for HIV	HIV clinical management
The Mobile Continuing Medical Education Project (mCME V.1.0,	Vietnam	HIV specialist physicians	Online modules and SMS	Six-month intervention consisting of daily SMS multiple-choice quiz questions, linked readings,	HIV testing and counseling, HIV in children, HIV in adults, ART in pregnancy, managing

Table 2 (continued)

	Location	Providers	Mode of delivery	Intervention summary	Focus of HIV education
V.2.0) (Gill; Larson Williams; Bonawitz)				links to online CME courses, and feedback messages describing the performance of the participant relative to the group	treatment failure, diarrheal diseases in HIV/AIDS, HIV and tuberculosis coinfections, HIV and viral hepatitis, common skin problems in HIV/AIDS, *Penicillium marneffei* infections, neurocognitive problems in HIV, palliative care, and methadone replacement therapy
mLearning Approach for Nurses Providing Option B+ Services (Kim)	Mozambique	Maternal and child health nurses	Tablets with preloaded modules	Tablet-based intervention comprised of 8 video vignette modules representing clinical cases related to a topic that was prioritized by nurses in the formative assessment, related to a skill or practice domain, and was essential to Option B+ delivery guidelines.	Group HIV counseling for Option B+, individual counseling and HIV testing, partner testing, initiation of ART and initial treatment side effects, care 7 and 30 days after starting ART, family planning, clinical analyses, monitoring, and evaluation of Option B+ Services
Acute HIV Infection Training Module (Rafferty)	Kenya	Primary care physicians	Online modules	Pilot testing of an acute HIV infection training module developed specifically for primary care clinicians. Primary objective was to assess knowledge gained from a self-directed online module focused on screening and improving testing of people with acute HIV infection.	HIV clinical management (acute HIV infection definition and importance of AHI recognition; symptoms and screening algorithms; diagnostic strategies; and management)
Tanzania Health Information System (T-HIT) (Thomas)	Tanzania	Maternal and child health workers	SMS and tablets with preloaded modules	Used tablet for digital data entry, healthcare reminders/prompts (reminding women to come back for prenatal visits and encouraging them to deliver at hospital), and weekly educational texts to HW on PMTCT care	Prevention of mother-to-child HIV transmission
Implementation Tool to Increase Awareness of a Clinical Practice Guideline to HIV Rehabilitation (Salbach)	Canada, UK	Occupational therapists, physical therapists, speech language pathologists	Email modules and Online repository	Six scenarios were designed to capture diverse sociodemographic profiles and acute and non-acute health conditions associated with HIV. Each case study included a case scenario, questions pertaining to the case and answers, and hyperlinks to facilitate quick access to relevant sections of the e-module to review additional information if desired. A new case study was emailed to participants every 2 weeks over a 10-week period.	HIV pathophysiology and associated conditions, interprofessional approach to rehabilitation assessment and treatment, psychological issues experienced by people living with HIV
New York State HIV-HCV-STD Clinical Education Initiative (Wang; Wang)	USA	Clinicians (including physicians, nurses, nurse practitioners, case managers, social workers)	Online Repository	Online repository of resources, including hundreds of multimedia learning modules, online CME/CNE courses, and guideline-driven interactive case simulation tools. Disseminated resources through a main website, mobile website, mobile apps, online social networks, rich site summary feeds and email newsletters.	HIV/HCV/STI clinical management
WhatsApp HIV/TB Clinical Discussion Group (Woods)	South Africa	Medical specialists; members of district clinical support team	WhatsApp	WhatsApp HIV/TB clinical discussion group for doctors who had attended an advanced HIV management course	HIV and TB coinfection

Table 2 (continued)

	Location	Providers	Mode of delivery	Intervention summary	Focus of HIV education
Hybrid approaches					
Training in HIV Testing Services for Children and Adolescents (Bertman)	Zimbabwe	Primary counselors	Tablets with preloaded modules and WhatsApp	Seven-week blended training included classroom sessions, tablet-based multi-media self-study (videos, podcasts, case studies, quizzes, reflection questions), and discussions using WhatsApp	HIV testing and counseling
DriSti (Ekstrand; Nyblade)	India	Nursing students and ward attendants	Tablets with preloaded modules	Tablet-administered, interactive intervention. Tablet session includes 4 modules combining video commentary by a narrator, interactive exercises, reflection on content, and summaries of key points.	Describing the concept of HIV-related stigma, reducing instrumental (fear-based) stigma
PrEP and HIV Prevention Curriculum (Frasca)	USA	Medical residents	Online modules	Course modules delivered online using Just in Time Teaching and supplemented with in-person direct clinical practice in a PrEP clinic as part of infectious diseases inpatient rotation	LGBTQ terminology, inclusive sexual history taking, LGBTQ and HIV-related health disparities, STIs, HIV risk assessment, PrEP candidacy and care delivery
Blended Educational Programme for General Practitioners' Trainers to Stimulate Proactive HIV Testing (Joore)	Netherlands	General practitioner trainers	Online modules	Three-month intervention using blended learning to help GP trainers mentoring medical students increase HIV testing, and their knowledge, attitudes, and satisfaction around HIV testing	HIV testing and counseling
Afya Bora Global Health Leadership Program (Nakanjako)	Botswana, Kenya, Tanzania, Uganda	Nurses and doctors	Online modules	Fellows are selected for 1 year of leadership training. They receive 8 weeks of didactic modules held at one of the African partner institutions, mentoring from in-country mentors, and three online modules to enhance a foundation in leadership, communication, monitoring and evaluation, health informatics, research methodology, grant writing, implementation science, and responsible conduct of research.	HIV/AIDS "updates"
Training Internal Medicine Residents to Provide Care and Treatment for HIV Patients (Valenti)	USA	Medical residents	Online modules	Two-year program with HIV lectures taught by an infectious disease physician plus a Q and A period (once every other month), followed by an online HIV training module	HIV clinical management

*Reisach and Weilemann were excluded from this table because they did not describe an actual program

convenience of not having to travel to facilitate or attend trainings, which reduces the costs for training significantly, but can only function if a number of conditions are met. A tradeoff is that it does not fully re-create the experience or quality of in-person training, and only partially solves the problem of access and convenience.

Asynchronous Learning

Five asynchronous interventions provided data on effectiveness in increasing providers' knowledge of HIV care and treatment [8, 18, 20–22, 25, 26]. The RCT of the mCME intervention in Vietnam found significant increases in knowledge based on performance on post-training exams, as well as a significant impact on increasing confidence in clinical practice [20–22].

Although wielding less power due to their cross-sectional and pre-post-test study designs, several other asynchronous interventions also demonstrated significant increases in knowledge based on performance on post-training exams [8, 18, 25]. In a another uncontrolled observational study evaluating the utility of a WhatsApp chat group formed around HIV/TB care, participating clinicians reported feeling more confident in their clinical management decisions. However, this study did not include any objective measures to see whether knowledge was improved [26]. In Tanzania, rural healthcare workers demonstrated increased knowledge and acceptability over time, but the difference was not significant [25].

Asynchronous eHealth education approaches allow students access to educational modules at any time, mitigating scheduling issues and need for high bandwidth required to sustain the Internet connectivity for tele- or video-conferencing. The content delivery is typically automated from a server and uploading new modules or questions can be done as easily as editing the source files in programs such as Excel, making it easy to edit or add new content with minimal information technology support. However, the modality is very impersonal, since it lacks a convenient way to foster discussion with the instructor or between students.

As the only fully asynchronous approach in this review evaluated by an RCT, the Vietnam mCME intervention offers important lessons for the field. In mCME, participants received daily SMS messages that contained multiple-choice quizzes and hyperlinks to direct users to more in-depth content, such as CME courses hosted by Hanoi Medical University. To increase participation in mCME version 2.0, the investigators incorporated a component of competition among the participants. After receiving responses to the daily quiz sent to them via SMS, participants received a report showing their scores compared to their colleagues. While the daily quiz did not require a significant time investment by users, the goal was to spur users to read the embedded hyperlinks to daily readings and to participate in the online courses [22]. In a companion analysis, the researchers showed that this strategy was effective at motivating clinicians to utilize the CME courses, while increasing unscripted self-study across a wider range of modalities (including textbooks) [33]. As a "cue to action," the daily SMS was effective primarily because it prompted users to be better self-learners. This is a subtle but important point: the benefit of eHealth education modalities may extend beyond the content delivered by the intervention itself, serving as a behavioral change stimulus (e.g., more self-study). However, timing of the quizzes was also important, even though the questions could be answered at any time. This may reflect a limitation of the simple SMS interface, where individuals tend to respond to SMS in real time, rather than leaving them for review later.

Other interventions also offer important insights. In sub-Saharan Africa, online courses were said to be appealing due to knowledge gains, format flexibility, and desire for recognition of course completion [7]. Rehabilitation professionals in the USA and Canada found courses delivered via email to be acceptable; however, they preferred receiving them in PDF versus in the body of an email [30]. Tablets were also seen as an effective and engaging learning platform, especially when paired with supportive supervision [18].

Hybrid Approaches

Of the six interventions using a hybrid of synchronous and asynchronous learning formats, only three reported findings on the impact on knowledge, attitudes, or behavior. One quasi-experimental study reported significant increases in knowledge based on performance on post-training exams [19]. These findings were confirmed in a cross-sectional study [10]; another study also demonstrated a significant impact on increasing confidence in HIV prevention [27].

The DriSti intervention to eliminate HIV-related stigma in India was the only hybrid intervention evaluated by an RCT. The evaluation showed significant reductions in stigmatizing attitudes among participants. The authors also noted that tablets were cheaper, easier to distribute and charge than computers, and did not require an Internet connection if material was uploaded in advance and accessible offline [23, 24]. A limitation is that the authors could only show changes in reported stigmatizing attitudes among those who used the system, but did not show behavior change. It is also possible that changed attitudes reflected social desirability bias, rather than true changes in beliefs.

Although less rigorously evaluated, providers in South Africa gave positive feedback on acceptability and use of text messaging as an adjunct to training courses and described SMS as a useful platform for information seeking, support, and case discussion [17]. The professional relevance of the topic area and participant feedback were reported to be important motivators for engaging in hybrid eHealth medical

education interventions [27, 28]; however, intervention effectiveness was uncertain given the lack of evidence provided on changes in knowledge or practice.

A number of challenges also exist in implementing hybrid interventions. One study identified reliable access to electricity, particularly in rural areas, as a barrier to successful implementation due to difficulty keeping tablets, phones, and computers charged. The lack of charge resulted in delays in accessing training content or adhering to assignment deadlines [17]. In addition, participants experienced limited space on phones for typing case descriptions, which could be better accommodated using tablets [17]. These technological challenges underscore the importance of providing supplemental material that is available offline and/or in a printable format, when possible [6].

A novel hybrid approach is virtual discussion groups that complement in-person training. Woods et al. reported a significant increase in participant engagement in a WhatsApp discussion group that followed an in-person training. The participants used the group to get guidance from their peers and obtain new clinical insights [26]. However, a limitation of this approach is that "engagement" is not the same as acquiring knowledge; at best, it can signal acceptance or enthusiasm, but is not itself proof that students acquired skills or concepts as a consequence of the intervention.

Discussion

This review demonstrates the wide variety of eHealth HIV medical education interventions that have been designed and delivered thus far, though the field is still rapidly evolving. There is no one-size-fits-all approach for eHealth medical education approaches. Rather, recommendations for developing interventions arise from exploring two overarching questions that emerged from lessons learned in this review.

1. What Are the Needs of the Learners?

The evidence shows that eHealth approaches for HIV medical education across multiple modes of delivery are acceptable, but a critical question is whether the mode of delivery matches the needs of learners. In our review, providers often sought support for HIV cases with complex medical and behavioral health issues, noting that access to mental health and substance abuse services remains particularly problematic in their communities. This underscores that when designing an eHealth education intervention, it is critical to involve a multidisciplinary panel that includes experts on an array of topics including mental health, substance use disorders, adherence support, and viral hepatitis coinfection [13]. Providers placed high value on learning from experts and observing and applying skills; an opportunity to engage with experts was found to be primary motivators for engaging in eHealth CME courses and should be considered in engaging instructors to design and/or deliver content [12]. Content should also be realistic, culturally competent, and relevant to the learner's area of practice [30]. Lastly, it is important to have a specific learner population in mind, with content relevant to the area of practice, and case studies, vignettes, or supporting materials that are realistic and informed by the lived experiences of PLWH [20–23, 30].

2. What is the Digital Landscape of the Context?

Designing eHealth education interventions requires a deep understanding of the digital landscape in order to choose the most appropriate modality of delivery (e.g., SMS, WhatsApp, tele- or video-conference, email, online), the educational format (synchronous, asynchronous, or hybrid), and the roles of partners. Assessing opportunities for technology ownership and capacity strengthening by key stakeholders to make interventions more effective and sustainable is also critical. The mCME intervention demonstrated the importance of collaboration with local Ministries of Health and stakeholders from intervention inception. The collaborators on this project gave development and ownership of the eHealth technology to Vietnam's Ministry of Health, thus enhancing its stake in the project and facilitating local adaptation [21]. Cross-national, technology-sharing collaborations like this one were observed infrequently in this review.

The key to answering these questions and designing successful interventions is working with the target population and tailoring the curriculum and delivery to its unique needs and resources. Collecting qualitative data prior to, during, and after implementation can play a critical role in this process.

Additional Evidence Needed to Advance the Field

This review demonstrates remarkable capacity for ingenuity in conceiving ways to employ eHealth approaches for HIV medical education. However, testing new strategies rigorously, disseminating findings, and focusing resources on translating best practices into widespread training are major gaps. Studies that cannot provide efficacy data cannot be used to prove or refute the effectiveness of eHealth modalities. A key finding of this review is that only two interventions were evaluated using an RCT design—the gold standard for assessing a new intervention. Among the remaining articles, the rigor and reliability of the evaluation findings varied. Thus, we found an absence of evidence of effect rather than evidence of absence of effect. As we have seen, the specific way in which content is delivered can have a profound impact on the effectiveness of the strategy, as shown between the mCME 1.0 and mCME 2.0 iterations [20, 21]. Given eHealth's potential to provide critical education to providers while saving time and money, it

is imperative to move this field from one of experimenting without testing or disseminating evidence, to one of evidence-based practices. This is analogous to the development of the wide array of HIV prevention and treatment methods that have emerged as a result of public health and medicine's innovations over the last four decades. The current paucity of evidence suggests that the potential to utilize eHealth modalities to support HIV medical education is still largely untapped.

Measuring long-term impact of medical education on clinical outcomes is a challenge due to time, budget, and lack of ability to control for other factors in real-world settings. However, using more rigorous mixed-methods evaluations would provide the opportunity to demonstrate short-term impact on gains in knowledge (quantitatively) and improve understanding (qualitatively) about why certain approaches work in different contexts and with different cadres of providers. There are also inherent limitations in how we define impact. It is difficult to demonstrate that having knowledge will improve clinical care—even if it is intuitive that such a link exists—because there are many steps separating knowledge gained through medical education from improved health at a population level. For this reason, assessments of the impact of medical education are difficult to take beyond demonstrating a change in clinician study habits (as a mediating variable) and the clinician's knowledge measured through a standardized examination. However, it is still essential that future evaluations of novel eHealth medical education strategies be accompanied by objective measures of impact. Improvement in knowledge can be assessed objectively and systematically; we see this as a relevant proxy measure for efficacy. Assessing changes in knowledge is feasible even in very small studies. Economic evaluations of these interventions would also generate valuable data on the cost implications of major eHealth interventions. Emerging evidence from a cost-effectiveness study of the mCME intervention in Vietnam shows that most of the costs are in upfront technology-based investment, which then can be used to promote CME (and perhaps support initial training) over the long run. Data such as these are crucial to persuading local and national health authorities to fund such programs, especially if they are meant to be long-term or large-scale solutions.

Conclusion

This review adds important lessons learned regarding the array of eHealth interventions for HIV medical education over the last 5 years and the methodology used to evaluate them. Technology has changed the landscape of training interventions, reaching people and making connections that would not have been possible before, especially at a much lower cost than in-person training. Despite the challenges of measuring effectiveness of eHealth for medical education, there is evidence that some interventions work well, but only from a small number of studies. Our review finds that eHealth approaches for medical education have been shown to be feasible and acceptable in synchronous, asynchronous, and hybrid learning formats. There is a need for rigorous studies to evaluate the impact of eHealth to support scale-up of these approaches to ensure an adequate number of trained HIV providers. These evaluations are also necessary to inform future interventions in different populations and settings. Lastly, our review's findings on the effectiveness of HIV medical education may extend to other topic areas in order to inform future eHealth interventions and move this burgeoning field forward.

Declarations

Human and Animal Rights and Informed Consent All reported studies/experiments with human or animal subjects performed by the authors have been previously published and complied with all applicable ethical standards (including the Helsinki declaration and its amendments, institutional/national research committee standards, and international/national/institutional guidelines).

Conflict of Interest The authors declare no competing interests.

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