

Readiness To Use E-Health Technologies: Concept And Assessment Tools

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Abstract:

E-Health Has Been Used In Various Disciplines To Reduce Health Illiteracy, Disseminate Health-Related Information, Store And Exchange Clinical Data, Increase Intra-Professional Communication And Communication Between The Health Care Provider And Patients And Facilitate Health Care Management And Access To Health Care Services. Scientific Evidence Highlights The Importance Of E-Readiness In The Adoption And Implementation Of E-Oral Health Technologies. However, To Our Knowledge, There Are Not Much Studies Highlighting The Use Of E-Oral Health Technologies In Pakistan.

Objective:

The Objective Of This Study Was To Explore E-Health As Well As Oral Health Technologies On The Basis Of Concept And Assessment Tools In The Field Of Dentistry.

Keywords: E-Health, Assessment Tools, Oral Health Technology, Readiness, Concept.

Date of Submission: 08-07-2023

Date of Acceptance: 18-07-2023

I. Introduction:

E-health is described as 'the use of information and communications technologies (ICT) in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research'.¹ It has become crucial to modern healthcare systems worldwide in the last decade.^{2,3} E health technology is important in improving healthcare quality, availability and its distribution, access to health care and information and health care sector efficiency and effectiveness.^{2,4,5,6} e health technology presents a solution by increasing the effectiveness of health services to improve patient centered outcomes and health care delivery.^{6,7} One such example is electronic medical records (EMRs), they have reduced the amount of errors in the prescriptions, increased patient compliance resulting in fewer hospital visits resulting in decrease healthcare costs.^{6,8,9,10} Recently, e health has been used in various disciplines to reduce health illiteracy, dissemination of health related information, exchange of clinical data, increase professional communication, facilitate and access to health care management and services.^{2,8} . It encompasses broad range of applications such as electronic health records, web portals, electronic medication, telemedicine, and teledentistry^{2,7}.

However, there are many challenges associated with e-health such as language, literacy, incomes and cultural norms that are crucial for the design and implementation of e health, still the overall prospects for growth is promising in the future¹¹ This scoping review is designed to survey selected dimensions of the current literature, specifically targeting tele health or e Health interventions at the patient or micro level. Literature at the larger macro level (i.e. populations and organizations) was also scanned with emphasis given to findings that relate to outcomes at the individual patient level.

Background:

E-health technology is progressing faster than it has ever been. The growing accessibility and use of information technology by the general population is the main driving force behind e-health technology^{2,9,10} . There has been a decrease in cost of e health technology coupled with enhanced digital infrastructure, that has increased the market value of e-health among health care providers. Therefore, this has made possible for healthcare organizations to implement new and cost-effective ways to provide health care.^{2,12,13} . It is estimated that by 2020 e-health will amount to 34 billion dollars of industry and would be an important part of modern health care system.^{2,14} .

Technology acceptance is a complex social and developmental process.² Individuals have certain beliefs and perceptions of technology that influence their adaptive behavior.¹⁵ Current research shows evidence of the acceptability and effectiveness of e health in the health care field. With the rapid expansion in digital technology, there would be an overabundance of user-friendly telehealth platforms that would fit different people lifestyles and health conditions.¹⁶

Concept of E-Health:

Electronic health (eHealth) readiness has been defined as the preparedness of health care institutions or communities for the anticipated change brought about by programs related to information and communication technology use. To ascertain the degree of such preparedness, an eHealth readiness assessment (eHRA) is needed.¹⁷ This scoping review is designed to survey selected dimensions of the current literature, specifically targeting telehealth or eHealth interventions at the patient or micro level. Literature at the larger macro level (i.e. populations and organizations) was also scanned with emphasis given to findings that relate to outcomes at the individual patient level. e-Health readiness has extended as far as considering environmental issues.¹⁸ It can be concluded from this and other literature that existing eHealth readiness assessment frameworks and tools show great inconsistency in content, definitions, and recommendations. The literature also demonstrates a need for the readiness frameworks and tools used, and readiness aspects applied, to be context-specific for the setting being considered and the stakeholder groups involved.¹⁹

Many studies have indicated the benefits of various e health technology and interest of policy makers to adopt e- health technology, however the implementation of e-health technology in the past decades has not been stable in the health care practice.,^{6,12} However, for the adoption of e health technology by the health care providers it is necessary to identify barriers that delay the acceptance process⁶. Around 70% of the use of e health technologies fails due to reluctance to use them. Failure to use them results in substantial losses in time, money (including opportunity costs) and effort¹³. More effort is expected toward users' privacy protection and use of data collected.²⁰ . This narrative review was aimed to gain an overview of concepts and assessment of r-health readiness.

E Health Technology: Implementation Barriers

Adoption of e-health technology is a complex process and it requires support from health care organizations, providers and patients. In a study done by de Grood, 2016⁶⁷, barriers faced by the health care providers were lack of synchronization of e-health system with the existing system as system integration was considered very important but health care providers wanted to use user friendly and easier spontaneous technology^{6,21-32}, confidentiality of health data⁷ (many) and privacy concern of possible hackers⁷. Cost and liability associated with maintaining e- health services, financial incentives to physicians to adopt e- health technology, loss of productivity during implementation process of e health technology, loss of patient physician interaction, lack of time experienced by physicians (ref) as they would need time to cope with the large amount of data produced by e-health technology⁶. It may also threaten physicians clinical independence as some might not be ready to give up their conventional clinical practice patterns and use electronic gadgets instead⁶. In addition to the above, more barriers are e-health illiteracy as some physicians lack the knowledge on how to use e health technology and probably require training, additional work burden for the health care providers, uncertain payoffs, professionalism and socio-cultural barriers⁶.

Apart from the barriers to the use of e health technology by the health care providers, there are barriers faced by health care organizations and at the patient level as well, and some overlap between the groups. At the health care organization level, barriers are e-health illiteracy by the staff, high cost of the technology to be installed at the offices, need for staff training, long-term sustainability of e-health platforms due to cost, and lack of evidence regarding its effectiveness⁶. At the patient level, barriers are e-health illiteracy, fear of technology; some do not feel comfortable to use it, privacy and trust concerns regarding their personal information, reliability of information and most importantly loss of direct contact with health care professional. Socio-cultural and socio-economic characteristics; depend on the culture and affordability by the patient because of high cost of e-technology, need for training, long-term sustainability of e-health platforms, and again lack of scientific evidence regarding its effectiveness⁶.

E Health Technology: Facilitators

With the barriers, there are facilitators to use e health technology by the health care providers, which were pre analysis of data, which includes screening and processing of raw data either electronically or by hand. Physicians preferred to see analysis of data rather than raw data to reduce fatigue generated by every report of patient's symptoms or treatment outcomes. Research Evidence showing proof of use of e health technology. Training and support to the staff is also an important facilitator, training should be tailored to the individual physician's knowledge of e health technology including follow-up sessions³³. Lastly, ownership and size of

practice, the bigger the practice and independent practices as compared to the group practices, are less likely to adopt e-health technology⁷. This could serve both as facilitator and barrier to e-health technology⁷.

E Health Readiness

E-health readiness is key to better understanding and implementing e-health technologies. E health Readiness is defined as “the degree to which users, healthcare institutions, and the healthcare system itself, are prepared to participate and succeed with e-health implementation”³⁴, whereas non-readiness is defined by Jennet et al⁶³, as “Perceived lack of need or failure to recognize a need for change and implementation of e-health technology³⁵”.

Rise of E-Health Readiness

E readiness goes back in early research on organizational change³⁶. Technology adoption and readiness is a multi-level and multi-dimensional construct and have largely been studied at two levels: the individual and the organization³⁷. The fundamental of organizational change theory is “creating readiness” by “reducing resistance to change”³⁶. Correlates of e health technology are perceived need for change and active participation in the change process³⁶. Walinga, in his article described the model of performance readiness based on firmness and resistance to change (pre contemplation), through acceptance of new ideas (contemplation) and to preparedness for change (preparation)^{36,37,34}. When organizational readiness for change is high, organizational members are more likely to accept change, put in more effort, show increased perseverance, and exhibit cooperation. Thus the result is more effective implementation resulting in effective production^{36,37}. It is also important to understand the role that cognitive and emotional processes play in the change process. Understanding the complexity and variability of the change process both the individual and the leader can respond better to and adapt the change process³⁷.

The scientific literature highlights the importance of e-readiness in the adoption and implementation of e-health solutions³⁸. Available data indicate e-health readiness is evaluated by assessing the status of healthcare institutions, government offices for embracing and implementing e health technology with the success of their health programs⁴. Weiner stated the following factors for the delay in adopting this technology; lack of knowledge of e-health concept at macro, meso and micro level³⁷. E-health readiness underlines the difference between suboptimal level and performance level in the use of e-health. It facilitates the process of change and is a critical antecedent to the effective use of e-health technology^{36,37}. In order to prepare individuals and organizations for new technologically innovative change, health care institutions and individuals need to familiarize themselves with e-health technologies^{2,39}. This process is exhaustive, time demanding and challenging in the initial phases, however by going through this process, e health technology can be acknowledged and prioritized in a manner that maximizes its efficacy and effectiveness in health care environment^{2,40}. E health readiness assessment could provide advantages, such as avoiding huge losses in time, money, and effort, avoiding delays and disappointments among planners, staff, and users of services and facilitating the process of change in the institutions and communities involved in the health care^{36,37,4}.

Dimensions (Determinants) of E health readiness

Nine types of readiness are identified in the literature at macro, meso and micro levels⁴¹. Governmental, organizational, societal readiness are categorized under macro level. Structural, technological and health care provider readiness are dimensions of e-readiness at the meso level, whereas engagement, core and public/patient readiness are dimensions under micro level⁴¹.

At macro level, governmental readiness, which gauges the extent to which a country’s government and politicians support and promote awareness, implementation, and use of e-health innovations. Organizational readiness includes presence of policies & management support. Societal readiness, a very important aspect of e-Health, encompasses the degree of ‘interaction’ associated with a healthcare institution. Interaction is described by three parameters; interaction among members of a healthcare institution, interaction of a healthcare institution with other healthcare institutions (link/collaborate), and interaction of a healthcare institution with its local communities.^{2,21}.

At the meso level, technological readiness is the ability of the health care organization to provide all the required technological requirements in the form of skilled human resources, ICT (Information Communication Technology) and technical structures, training, needed hardware and software and network infrastructure. Structural readiness includes the development of infrastructure such as adequate human resources as well as necessary training for telehealth implementation. Health care provider readiness is the experience, perception and willingness of providers towards the use of e-health technology^{21,42}.

Lastly, at the micro level, engagement readiness gauges the extent to which members of a community are aware to the concept of e-health, willing to be trained and are actively debating its advantages as well as disadvantages. Core readiness gauges the extent to which members of a community are dissatisfied with the

current status of their healthcare service provision, see e-health as a solution, and express their need and preparedness for e-health services. Core/Need/Motivational readiness in healthcare services, which when delivered can improve the quality of care, accessibility and reduce cost. It is a process of identifying and addressing the needs or the gaps between existing settings and the desired results^{2,43}. Public/patient readiness gauges the extent to which members of the public and patients are aware of, can afford and access e-health services. It also involves assessing the influence of their personal experiences on their perception and receptiveness towards the use of e-health technology^{2,44,45}. Health Information Technology (HIT) readiness refers to the preparedness of healthcare institutions or communities for the anticipated change brought by programs related to ICT².

E readiness Theoretical Frameworks

Various theoretical models have been proposed that explain the e-health technologies, and its adoption⁴⁶. These theoretical models may be used as guidelines for assessing the HIT adoption readiness². Literature has also identified many frameworks that describes patient readiness to use e-health. Various concepts, such as the Theory of Change and Rogers' Innovation Diffusion Theory, have been used to explain e-readiness, its adoption process and barriers and facilitators for the implementation of e-health technologies^{2,47}. Other theories are Theory of reasoned action⁴⁸, Theory of Planned Behaviour, Technology Acceptance Model^{48,49,4} (96,97, 98), Activity Theory^{46,60} (92, 94), Motivational Model (1997) Unified Theory of Acceptance and Use of Technology (UTAUT)⁴⁹ and Technology Lifecycle Theory^{49,50}. Among multiple e readiness assessment models in the healthcare sector today, following six models are the common ones. 1) Build Cross-Agency Partnerships and Clarify Roles, (2) Identify Sector or Industry and Engage Employers, (3) Design Programs, (4) Identify Funding Needs and Sources, (5) Align Policies and Programs, and (6) Measure System Change and Performance.⁵¹

These models are proposed by Campbell et al. (2001)⁶¹, Demiris et al. (2004)⁶², Jennett et al. (2005)⁶³, Overhage et al. (2005)⁶⁴, Wickramasinghe et al. (2005)⁶⁵ and Khoja et al (2007⁴, 2005, Jennet)⁶³.

Activity Theory

Activity Theory roots back to Vygotski's studies on cultural-historical psychology in the 1920s^{66,29}. Engeström in 1987 described activity theory in a socio-technical system through six different elements including mediating tool, subject, object, rule, community and roles⁵².

Activity theory (Figure 1) offers a framework to analyze the complex social interactions between, individuals and their environment including social tools⁴⁶. It is based on Coleman and Coleman's study, in which activity theory was proposed as a context for the evaluation of e-health readiness in health institutions^{2,30}. The available literature suggests that Activity theory is applicable for better understanding and solving issues related to e-readiness, e-learning and their associated factors³⁰. Activity theory is a conceptual framework based on the idea that activity is primary, that doing precedes thinking, that goals, images, cognitive models, intentions, and abstract notions like "definition" and "determinant" grow out of people doing things⁵³. Furthermore, this theory is compatible with qualitative research methodology because of its holistic and theoretical existence to investigate human activities such as e-oral health technology^{2,49}. The activity is the basic unit of analysis. The subject represents the activity system as basic unit of analysis and is the person who works towards the object in the system. In turn, the object leads to the result. The subject's activities are mediated via tools. Rules, community, and roles support the entire system⁴⁶. These factors influence the action leading to the outcome such as use of e-technology. Rules are defined as a set of conditions that determine how people can act⁴⁶. The relationship between the individual and their environment is assessed through the community⁴⁶. Rules mediate the connection between subject and society and the connection between object and society is mediated by the individual's roles^{46,54}.

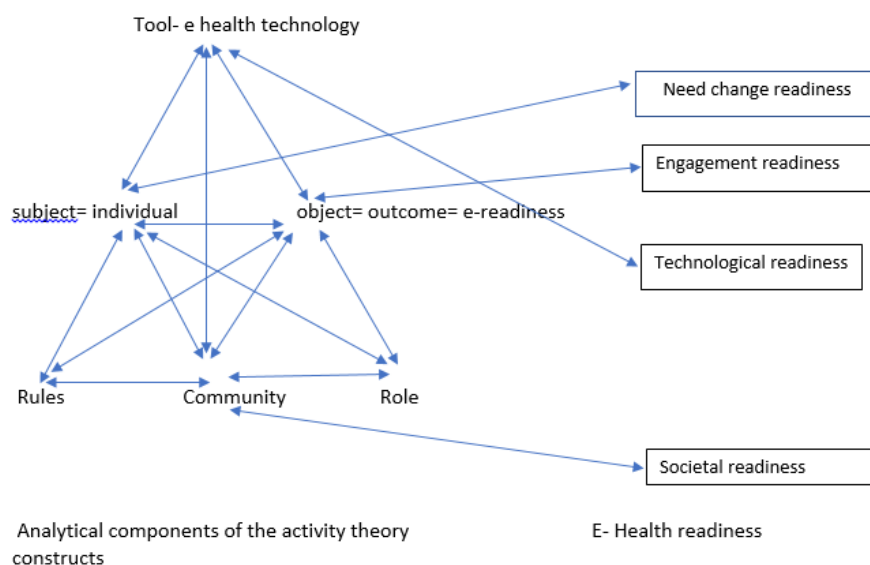


Fig 1: Activity Theory Framework: A Basis for E-Health Readiness Assessment in Health Institutions (Adapted from Coleman&Coleman, 2013, A 92)⁴⁶

E-HEALTH READINESS ASSESSMENT TOOLS

Several e-readiness assessment tools in areas such as e-business, e-commerce, e-learning and e-health were developed to determine the importance of e-readiness in the implementation of e-health technologies in health care systems^{3,4,55,46} **Table 1**. These tools have mostly been used to guide the organizations in evaluation, diagnosis, treatment selection and resources for patient care. Most of these tools are helpful in current situations of health care organization's or community's willingness to implement e health technology^{3,4,46}. Efforts to develop readiness assessment tools for e-health programs have taken place in Ontario and Alberta provinces in Canada. The tools to assess e-health readiness in healthcare institutions and communities have been developed in the developed world⁴ but not in the developing nations. In developing countries, these tools should address the key determinants of e-health relevant to their context, along with issues such as needs assessment, implementation, and evaluation, to comprehensively assess e-health readiness by the healthcare institutions. The e-health readiness assessment tools should help in improving the quality of e-health programs in healthcare institutions, as well as increasing the awareness and trust among staff and policy makers associated with e-health applications⁴. The tools should also help address technology and learning issues among staff, communication with the patients, health care providers and reduce barriers to the use of e technology⁴.

According to systematic review conducted by Yusif et al. in 2017², various dimensions of e-health readiness have been measured by unreliable and non-validated measurement tools.

They found that "Technological readiness", "Core/Need/Motivational readiness", "Acceptance and use readiness", "Organizational readiness", "IT skills/Training/Learning readiness", "Engagement readiness", and "Societal readiness", all had unreliable measuring tools. Only Core readiness had relatively reliable measuring tools, which has been repeatedly used in various readiness assessment studies³. Therefore, there is a need for developing reliable tools for even the most commonly used readiness assessment factors and constructs³. Khoja et al developed e-health readiness assessment tools for public and private healthcare institutions in developing countries. In their study, the separate tools for managers and healthcare providers contained 54 and 50 items each. Each tool contained four categories of readiness namely core readiness, societal, policy readiness, technological readiness (meso level, managers), learning readiness (macro level, stakeholders). Each item was rated by the respondent using a five-point Likert type scale⁴. With appropriate contextual evaluation, it is expected that e-health readiness assessment tools would find broader applicability in developing countries, preparing them for introducing and adopting of e-health technology⁴.

Table 1. Theoretical frameworks - Technology adoption theories

Theoretical Frameworks			
Diffusion Theories	User acceptance theories	Personality theories	Organizational Structure theories
Diffusion of Innovation Theory Def: Adoption and implementation of new ideas, processes, products, or services with emphasis on diffusion of innovation within and across organizations. Roger work primarily focused on individuals and some on organizations. Roger 1995- identifies four main elements that form the theory namely The innovation, communication, time, and the social system. (Rogers 1962)	Theory of Reasoned Action (Ajzen and Fishbein 1973,1975)	Technology Lifecycle Theory (Rogers 1962; Moore 1995)	Disruptive technology Theory (Bower and Christensen 1995)
Technology Lifecycle Theory (Rogers 1962; Moore 1995)	Theory of Planned Behaviour (Ajzen 1991)	Non-technology approaches: Social Cognitive Theories (Compeau and Higgins 1995)	Creative Destruction Theory (Schumpeter 1912, 1942)
	Technology Acceptance Model (Davis 1989)		
	Motivational Model (Vallerand 1997)		
	User Acceptance of Information technology (Vankatesh et al. 2003)		

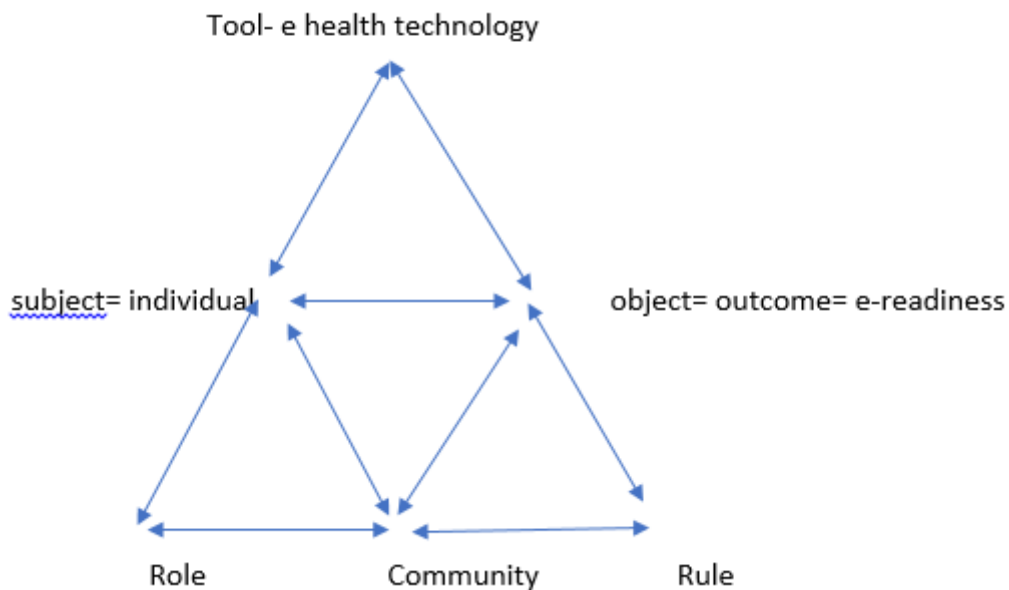


Fig 2: E-Health Readiness Assessment Tool

Readiness for E Oral health (Teledentistry)

E oral health can be broadly described as the use of information technology in dental practice, education, research, and management⁵⁶. E-oral health is an innovative technology capable of addressing current problems in accessing oral health care. Modern oral health care is a remarkable achievement. Now, digital technology is taking dentistry to another level, creating practice possibilities that were hardly imaginable ten years ago^{2,13}. Today, e-oral health technologies are used for dental consultations, educational programs, screening and disease diagnosis, as well as providing dental training and care in various disciplines including dental public health, preventive dentistry, orthodontics, prosthodontics, oral surgery and oral medicine^{2,36}. It increases office efficiency and production in dental offices³⁶. It creates public awareness with the intention of enhancing oral health worldwide^{2,43}. The use of these technologies has also facilitated communication between general dentists and specialists for consultation and treatment planning when dealing with difficult cases^{2,21,36}. Both the dentists and patients ultimately will benefit from teledentistry and electronic commerce, or e-commerce^{2,43}. Recently, the E-Oral Health Network was created in the International Association of Dental Research to encourage and enhance research studies in this field⁵⁷. This network also facilitates communication and collaboration between researchers in the fields of dentistry and health information technology^{2,57}.

Scientific literature highlights the importance of e-readiness in the adoption and implementation of e-oral health technologies. Nayar et al validated a survey tool (PRAT), Practitioner readiness assessment tool to test the readiness of oral health professionals for teledentistry (TD) in USA. The tool gathered information about the participants beliefs, attitudes and readiness for teledentistry before and after the training program. The majority of the trainees acknowledged a positive impact of the training on their readiness for TD⁵⁶.

Pentapati et al.⁵⁸ conducted a systematic review and identified various clinical applications of e-health in endodontics, periodontics, oral medicine, oral maxillofacial surgery and orthodontics. According to this review, e-oral health technology can be used effectively in the field of endodontics and periodontics for diagnosis of periapical lesions⁵⁸. Marino et al⁵⁹ conducted a systematic review in 2013 to explore e-oral health applications and its use in several dental specialties like oral surgery, oral pathology and oral medicine. The most common type of teledentistry application was found in educational programs, followed by diagnosis, consultation and treatment. Teledentistry studies were reported in a total of 15 countries with the largest number of studies conducted in the US⁵⁹. The study results depicted the utilization of e technology for consultation within dental communities, oral disease screening and collection of epidemiologic and clinical data^{2,59}. In oral medicine, e-oral health is used to capture high quality images of oral mucosal lesions of patients and to screen for oral premalignant lesions^{2,58}. In the field of oral and maxillofacial surgery, e-oral health applications are useful for general dentist for communication with specialists

to discuss diagnosis and treatment planning^{2,58}. In addition, they can be useful in monitoring, evaluation of healing, dentoalveolar fractures, impactions, abscesses and pericoronitis⁵⁸. In the field of orthodontics, e-oral health applications have been useful for dentists to consult with a specialist via a virtual clinical examination, and it appears that orthodontic treatment planning is as accurate as by direct clinical examination⁵⁸. According to this systematic review, dental practitioners showed satisfaction with the use of e-oral health technology⁵⁸. Flores-Mir et al.³⁶ conducted a survey in 2016 to examine dentists' perception and attitudes towards using digital technology³⁶. Their survey analyzed responses of Canadian dentists and found that 60% of these dentists were satisfied using the e-oral health technology and perceived that e-health technologies are useful in connecting general dentists to specialists, as well as improving their workplace efficiency and production³⁶. The review indicates that although e oral health is an area of expansion, there are still some barriers to its increased use^{36,59,58}.

II. Conclusion:

A better understanding of e-health is of public health importance since it could lead to the implementation of effective policies based on patients' perceptions and needs. The concept of e health readiness needs further research and e health readiness assessment tools need to be developed and tested in several studies to prove their effectiveness. As the E health technology field continues to expand and mature rapidly, there is a need for larger scale rigorous studies including creative approaches to developing, implementing, and enhancing e health including e oral health technology. Additional attention to implementation science technique is recommended to build the knowledge base that is so desperately needed in e health technology as global tele-health projects accelerate.

List of Abbreviations:

1. (ICT)- information and communications technologies
2. (EMRs)- electronic medical records
3. (eHealth)- Electronic health
4. (eHRA)- eHealth readiness assessment
5. (PRAT)- Practitioner readiness assessment tool

6. (TD)- TeleDentistry
7. (UTAUT)-Unified Theory of Acceptance and Use of Technology
8. (HIT)-Health Information Technology

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