

Mobile Health Applications: Enhancing Pathology Services with Patient Engagement Tools

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ABSTRACT

Patient engagement, also known as patient and public involvement, patient involvement, or stakeholder engagement, is a type of participatory action research in which patients and carers "coproduce" the research. It has been described as the development of significant and ongoing partnerships in research governance, priority setting, conduct, and information transmission between researchers and patients (including unpaid carers). One of the contending theories explaining patients' relatively poor acceptance of mHealth is because end users' perspectives were neglected during the development process. Thus, one of the most important steps towards the broader acceptance of patients and carers as coproducers of mHealth research is to facilitate a better understanding of the protocols for involving them in these studies. Our findings demonstrate that including patients and carers in research through the establishment of an advisory panel yields a valuable information source that could guide the development of a mobile health app during the period preceding heart surgery. In addition to seven key design-specific messages about access, tracking, synchronisation, and reminders, members of the advisory panel produced sixteen key content-specific messages about medical terms, professional roles, cardiac surgery procedures and recovery, travel, nutrition, medications, resources, and physical activity. These findings are unusual since patient engagement is still underutilized in several health research domains, including as cardiac surgery and mHealth design, despite the growing understanding of the value of involving patients in research.

Keywords: Mobile Health Applications (MHP), Enhancing Pathology services (EPS), Patient Engagement Tools (PET)

INTRODUCTION

These days, science and technology have made such success in the field of medical science that there is no need for specific labs at a particular place to perform any health-related tests. Rather most of these services have become remote and mobile. When we talk about pathology services, actually we are talking about services of pathology labs for the diagnosis of pathogens. Now pathology services have also become mobile in different ways. In this introduction, we are going to discuss how Mobile health applications can be used in the case of pathology services. This introduction will also cover some engagement tools of pathology services relevant to patients for Mobile services[1]. There are many vast and versatile mobile Health Applications of pathology services which can provide benefit in different ways. The first and foremost benefit of Mobile health applications of pathology services is that they can provide various patient portals. These portals are designed to provide websites for information related to pathology services, the schedule of that particular pathology lab, online bookings for appointments, and others. The medical history and test results have also been uploaded on these portals for better access to the medical history of any particular patient. The other important benefit of using mobile Health Applications of pathology services can be explained in terms of symptom tracking[2]. This is the most modern benefit of Mobile health applications in which only symptoms are logged on a specific website and then pathology lab experts monitor these symptoms to conclude any results remotely. The main objective of this symptom tracking is that there is no need for physical visits of patients at pathology labs again and again because all the results of tests are provided online now. The other important implication of Mobile health applications in pathology services is that telemedicine integration. Usually, patients visit hospitals to seek guidance relevant to a particular medicine but by this application of telemedicine integration, the medical experts study pathology lab tests online then

they suggest specific medicines according to the needs of the body[3]. These meetings of patients and clinical experts can be arranged with the help of video conferences so there is no need for physical visits of patients at hospitals from time to time. The other important benefit of Mobile health applications relevant to pathology labs is the aspect of medical adherence. As we know the proper medication is mandatory to prevent and treat any ailment. Each dose of medicine must be taken at a specific and regular time to get positive outcomes. This Mobile health application of medical adherence will help patients in this way it will send notifications for medicine doses, reminders of specific diet plans, the true quantity of medicine, and preventive measures[4]. All of these aspects will help patients in reducing rehabilitation period by taking medicine regularly. The other most important benefit of Mobile health applications of pathology labs is personalized health information. These mobile Health Applications are better in this way that the whole information about health of any specific patient is uploaded in this application. Then this application gives a diet plan of that patient according to the health and medical history of the patient. The other important benefit of Mobile health applications of pathology services is the aspect of electronic health records systems which are abbreviated as EHRs[5]. The main objective of an electronic health record system is that there is no need for any manual work in this system of storing data. The other benefit of electronic health record systems is that there is very little risk of data loss in such systems as compared to primitive ways of data record systems. The third benefit of an electronic health record system is that the data of any particular patient can be accessed at any time within a fraction of a second at any place. There are various tests on patients related to pathology and such tests are performed in more than one pathology lab. So these pathology labs can be coordinated and connected with the help of an electronic health record system. The next benefit of Mobile health applications for pathology

services is that they can be used for appointment reminders[6]. In some diseases, there is a need for regular appointments with clinical experts who monitor that specific case of a patient from time to time. Mobile Health Applications are reliable in this way that these apps remind about appointments of patient with medical health experts. The next benefit of using mobile Health Applications for pathology services is the accurate and swift results with notification. Once the sample is taken for diagnostics, the patients have to wait for a few hours to get results depending upon the type of diagnostics. But by using this Mobile health application, there is no need to wait at the hospital but the patient can come home because he would get the results of that report on the phone with a notification as well[7]. There are many benefits of using mobile Health Applications in terms of patients. The first and foremost benefit is that it increases the level of patient satisfaction which is very important these days. The schedules and appointments are mostly online but if they are physical, these appointments are arranged by keeping in view the satisfaction and easiness of patients. Most of the pathology services have become online which gets much attention and satisfaction from patients[8]. The other benefit of using mobile Health Applications is that the workflow can be optimized in a short time.

When most of the services are provided online, there will be less physical and manual work, so the workflow can be improved. The other important benefit of Mobile health applications is that the cost of such systems is very low and results are very accurate and error-free[9]. Usually, most of the cost in medical expenses is used in day-to-day visits to hospitals and pathology labs but when these services are provided online, much of the cost can be saved in terms of medical expenses. All these applications make mobile Health systems a better strategy for pathology labs[10].

Research Objective

The main objective of this research is to provide information about the term mobile Health Applications and how it can be beneficial in pathology labs. This study has explained in a better way about advancement in pathology labs for providing mobile services.

LITERATURE REVIEW

Researchers claim that the health sector is categorized as one of the most complex sectors that require technology-based systems for performing complex activities. The technology used in health sectors to help to change complex tasks into simpler ones. The quality of services provided by the health complexes is controlled by the implementation of AI in these industries[11]. Studies show that health industry 4.0 has fully adapted to the use of AI. The patient care journey in health sectors gets improved using digitalized health devices. Also, the patient physical condition is continuously tracked in health sectors using AI sensor machines. The process of intervention provided to medical patients is improved through the digitalization of medical services[12]. Studies suggest that identification of any disease is possible by understanding the protein expression alternation caused in patients due to that disease onset. To study the alternation in protein expression the use of digitalized devices is preferable in pathology labs. By studying protein expression it becomes easier to develop a precise medication against that disease condition[13]. Studies reveal that a large number of the world population benefits from the use of m-health apps. These apps are specially developed to provide health services to people living in remote areas. To understand the impact of

health apps on people questioners-based assessments were made in different countries of the world. The experience of people regarding the use of M-health app was identified using conservation related questioners [14]. The mobile health apps are specially built to improve the self-health management process. The quality of healthcare apps determines the commercial importance of these apps. Most of public mobile health apps are developed based on the policies developed by healthcare professionals. The policy-making step before the implementation of mobile apps in society is critical. This step ensures that only authentic and useful health-related information is provided to the public[15]. Studies elaborate that the cost in the health sector has greatly reduced because of m-health applications. The quality of treatment provided to patients has improved as the m-health apps used have increased. There are numerous factors that influence the use of m-health apps by physicians. The most important factors are social and medical organizational factors[16]. Studies reveal that the accuracy of medical health reports has increased because of the use of ML in medical sectors. The shortage of skilled and professional health professionals in medical sectors has been overcome using AI-based medical systems[17]. Studies show that using smart health applications provides faster information related to the heart rate and blood pressure of a person. The information regarding health-related parameters helps identify the health status of a person. Wearable health tracking systems have commercial importance as these systems provide information regarding physical condition[18]. A scholar explains that data related to health sectors is in large volume. To collect and store medical records related to patients the use of mobile health apps is common. Physicians around the world are using m-health devices to provide patients with improved quality health opportunities[19]. Scholars' studies concluded that the quality of CRM improves through AI-enabled software. Medical services have been innovated by the process of AI-based medical software[20]. Studies predict that communication between patients and physicians has improved with the help of technology systems. The traditional process involved in providing medical-related services to patients has been replaced with smart medical services systems. In today's world patients are educated about their health conditions to guide patients to self-manage their health conditions during the recovery period[21]. Moreover, the patient needs to become self-aware about their medical condition. Medical patients who show improvement because of self-healing programs are most likely to fully recover from their disease condition. The awareness regarding diabetes type 2 disease in patients helps patients in their self-disease management journey[22]. Studies explain that social media actively plays a great role in making people aware of severe health diseases. Mobile health apps educate people with chronic kidney disease about the food they need to intake to improve their health condition[23]. Studies reveal that the chances of survival of cancer patients have increased in the last few decades because of the two awareness approaches. The efforts awareness approach is mobile health apps, and the second approach is not medical checkups. Both these approaches help in diagnosing early-stage cancer patients[24]. Studies suggest that by engaging people in health activities mobile health apps have revolutionized the process of providing health services. By integrating M-health applications in clinical trials the scope of improvement in clinical practices increases. Also, the real-time monitoring process of patients is done using the wide applications of m-health[25]. Studies suggest that the prevalence rate of neurological diseases in the population is increasing at an alarming rate. Rehabilitation to treat neurological diseases is

important for patients. neuro-rehabilitation is a process provided to patients to engage them in treatment against neurological diseases. digitalized rehabilitation processes are widely accepted to treat the severity associated with neurological disease[26]. Studies claim that acceptance of M health services is different in low and high-income countries. In low-income countries people are mostly unaware of the use of modern health apps and technology therefore the trend of using m-health apps in low-income countries is low. In low-income countries the use of modern and advanced technology is prevalent and therefore the trend of using m health apps in these countries is much higher[27]. Moreover, in the 21st century, the need for modern technology has increased in almost every field. In health institutes, hospitals and clinical laboratories the AI based software are implemented. the health data of patients in hospitals is stored in the form of EHR[28]. Studies predicts that people of modern world are introduced with the approach of personalized treatment through the use of m-health apps. The capability of medicals sectors to provide improved diagnostic tests is possible by using AI based algorithms in diagnostic lab setups[29]. Studies claim that adoption of AI software is not limited to health sector but this software is now used in clinical and pathology labs. The framework of health-related jobs is made customizing the applications of AI. main use of AI in health sector is benefiting the health sectors and also the health professionals. The burden on physicians have reduced because AI has revolutionized the mode of medical health services[30].

Methodology

The research determines that mobile health applications for enhancing pathology services. The research based on primary data analysis for determine the research used SPSS software. The descriptive statistic, paired correlation coefficient analysis, the test statistic, also that linear regression analysis between them. The repetitive schedule of daily routine has made people busy to such an extent that they find it difficult to visit pathology labs for relative purposes. In this view, people are mostly satisfied with those services that are available online through the Internet. Mobile health applications are one of the benefits of pathology labs to avail pathology services through the internet. It has provided with various services of pathology labs with fingertips for easiness and satisfaction of people to save time. The following are important implications of Mobile health applications that can enhance pathology services by using such tools that are engaged with patients:

Notifications on Mobile, Pre-Booking of Appointments, and Tracking of Symptoms

Because mobile Health Applications are mostly based on the internet anyone using the internet can avail of these services easily. All the important notifications related to pathology lab services are sent to mobile phones to keep people updated about pathology lab services. These types of Mobile notifications can also be used for marketing pathology labs on various social media platforms. These notifications can also be used to remind people about their appointments in pathology labs. Some specific types of diagnostic tests are performed in pathology labs after a particular type of diet and specific type of diet schedule. Such diet plan of patients can also be updated on these Mobile health applications so that patients may remain relaxed about their diet plan and they do not need to visit pathologist again and again. The appointment schedule and its pre-booking have always

been a problem for patients related to pathology lab services. Sometimes patients are unaware of the schedules of pathology labs, sometimes there may occur an emergency in the pathology lab which may result in a halt in activities. Sometimes we have seen that people find difficulty in finding the exact location of pathology labs. All these problems can easily be solved by mobile Health Applications. These applications provide accurate and timely information about the location of the pathology lab, relevant services, and schedule of appointments, pre-booking, and many other facilities. Now by using mobile Health Applications, most people make appointments online so they do not need to wait long for their turn. This method not only saves the time of patients but also helps in better management of time at pathology labs as well. When the results of relevant tests are analyzed, the patient may get a notification of these results too. The other important implication of Mobile health applications in pathology labs is that they can also assist in symptom tracking. We all know that there are some symptoms related to some particular disease, when these symptoms are shown, it is clear that a pathogen has entered in the body. The treatment will become easy if symptoms are tracked on time. The Mobile health applications provide the facility of online symptom tracking. There is such health applications installed on mobile phones in which people have to enter their symptoms and they will automatically get an idea about pathogens and disease. These are important implications of Mobile health applications in pathology labs which describe about benefits of Mobile health applications.

Patient Education, Telemedicine, and Health Record System

Mobile Health Applications are not only a source of information and assistance for patients related to pathology labs but there are also some means for medical education of masses. We know that science and technology have made success to such an extent that it made us aware of types of pathogens along with the mode of transmission of these pathogens. All of this research information related to pathogens can be used to raise awareness among people. Mobile Health Applications are the best methods for spreading awareness to people in a short time. The other implication of Mobile health applications in pathology labs is that they can help in telemedicine integration for patients. It can provide consultation to patients through video conference so there is no need for physical visits of patients to pathology labs. All the consultations related to medicine, diet plan, and exercise plan can also be provided by telemedicine integration. This implication of Mobile health applications helps save time for patients along with providing multiple consultations at the same time from different pathologists all over the world. The other important implication of Mobile health applications is the electronic health record system of pathology labs which is termed as EHRs. This system is computer-based and store data in electrical signal form. Because all the data is stored in a computer so there is very little risk of data hacking or data loss. All the data related to pathology labs can easily be accessed at any time at any time within a fraction of a second. These health record systems can also be updated on Mobile Health Applications. These important implications of Mobile health applications make them more effective these days because of various benefits.

Mobile Payment and Navigation Through Mobile Applications

As for pre-booking of appointments, symptom tracking, and analysis of results, telemedicine integration can be done by online systems using Mobile health applications. But there is also another

implication of Mobile health applications is that they can be used for online payment of dues of pathology labs. This online payment method by mobile Health Applications is secure and trustable. The other important implication of Mobile health applications in pathology labs is the navigation of the location of pathology labs by using Health Applications. Sometimes the exact location of pathology labs is unknown to any patient which can act as a hurdle to the services of pathology labs. The exact location of any particular Pathology lab

is updated on the specific website of that pathology lab or mobile Health Applications of that pathology lab. The other important implication of Mobile health applications in pathology labs is laboratory information systems which are abbreviated as LIS. This system helps to update all the relevant information of the pathology lab to different mobile Health Applications. These are important implications of Mobile health applications which are described here in an effective way.

Table 1: Result of Descriptive Statistics

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Mobile Health Applications 1	51	1.00	3.00	1.7255	.63493
Mobile Health Applications 2	51	1.00	3.00	1.4314	.57463
Mobile Health Applications 3	51	1.00	3.00	1.6275	.63121
Enhancing Pathology Services 1	51	1.00	3.00	1.5686	.57463
Enhancing Pathology Services 2	51	1.00	3.00	1.6667	.65320
Enhancing Pathology Services 3	51	1.00	4.00	1.8235	.71291
Patient Engagement 1	51	1.00	3.00	1.6078	.63493
Patient Engagement 2	51	1.00	3.00	1.5882	.63801
Valid N (listwise)	51				

The above result shown in table 1 represent that descriptive statistical analysis result demonstrate that minimum values, maximum values, mean values, also that standard deviation rates of each variables included dependent and independent. The result describes mobile health applications related to enhancing pathology services with patient engagement tools. The mobile applications 1, 2, and 3 these factors consider as independent variables according to the result its mean value is 1.7255, 1.4314, 1.6275 the standard deviation rate is 0.57, 0.63 its shows that 57% and 63% deviate from mean. The enhancing pathology services 1, 2, and 3 these factors consider as

dependent variable result demonstrate the mean values is 1.667, 1.8235 and 1.5686 its shows that positive average rate the standard deviation rate is 57%, 65% and 71% deviate from mean.

According to the result its minimum rate is 1.000 and maximum rate is 4.00 respectively. The patient engagement 1 and 2 both factors consider as mediator variable according to the result its mean values is 1.6078 and 1.5882 its shows that positive average rate and its shows 63% positive deviate from mean values related to the mobile health applications for enhancing pathology services.

Table 2: Result of Paired Samples Correlations

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	Mobile Health Applications 1 & Enhancing Pathology Services 1	51	.327	.019
Pair 2	Mobile Health Applications 2 & Enhancing Pathology Services 2	51	-.409	.003
Pair 3	Mobile Health Applications 3 & Enhancing Pathology Services 3	51	-.238	.093
Pair 4	Mobile Health Applications 1 & Patient Engagement 1	51	.273	.052
Pair 5	Enhancing Pathology Services 1 & Patient Engagement 2	51	.160	.261

The results mentioned above in table 2 show that the correlation value and significant value of each pair are described by the paired sample correlation analysis results. The first pair, which consists of improving pathology services 1 and mobile health applications 1, has a correlation rate of 0.327, a significant level of 0.019, and a positive 19% significant correlation between them. The second pair, which consists of Enhancing Pathology Services 2 and Mobile Health Application 2, demonstrates a negative and 3% significant rate between them with a significant level of 0.003. Comparably, the correlation value between the mobile health application 3 and the enhancing pathology services 3 is -0.238, with a significant level of 0.093. This

indicates a current negative but 9% significant rates between them. The fourth pair, mobile health applications 1 and patient engagement 1, indicates a positive and 5% significant rate with each other, with a correlation value of 0.273 and a significant level of 0.052. The last pair, improving pathology services 1 and patient engagement 2, has a substantial 26% and a positive 0.160 correlation rate. Patients, carers, and other health service users may participate as research participants or coresearchers in mHealth development studies through the use of participatory methods such as user-centred design, the participatory action research framework, and the Centre for eHealth Research and Disease Management Roadmap.

Table 3(a): Result of Paired Samples Test

TABLE 2(A). Result of Paired Samples Test									
		Paired Samples Test					T	df	Sig. (2-tailed)
		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Mobile Health Applications 1 - Enhancing Pathology Services 1	.15686	.70349	.09851	-.04100	.35472	1.592	50	.118

Table 3(b): Result of Paired Samples Test

		Paired Samples Test					T	df	Sig. (2-tailed)
		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 2	Mobile Health Applications 2 - Enhancing Pathology Services 2	-.23529	1.03128	.14441	-.52535	.05476	-1.629	50	.110
Pair 3	Mobile Health Applications 3 - Enhancing Pathology Services 3	-.19608	1.05867	.14824	-.49383	.10168	-1.323	50	.192
Pair 4	Mobile Health Applications 1 - Patient Engagement 1	.11765	.76543	.10718	-.09763	.33293	1.098	50	.278
Pair 5	Enhancing Pathology Services 1 - Patient Engagement 2	-.01961	.78715	.11022	-.24100	.20178	-.178	50	.860

The test statistical analysis result shown above in table 3 shows the mean values, standard deviation values, and 95% confidence interval rates in addition to the significant level of correlation between them. The first two are improving pathology services and mobile health application 1. It reveals that the t statistic value is 1.592 and the mean value is 0.156. Moreover, the noteworthy rate is 0.118. It demonstrates that their analysis was 11% significant and positive. The pair 4 report

that the t statistic value is 1.098, the mean value is 0.1176, and the significant rate is 0.278, indicating a 27% significant level of agreement between them. Pathology services 1 and patient engagement 2 are being improved by pair 5. It indicates that -0.01961 is the mean value. -0.178 is the t statistic value. The increasing pathology services 1 and patient engagement have a negative and 86% significant relationship, as indicated by the significant level of 0.860.

Table 4: Result of Model Summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.502 ^a	.252	.169	.59543
a. Predictors: (Constant), Patient Engagement 2, Patient Engagement 1, Mobile Health Applications 3, Mobile Health Applications 1, Mobile Health Applications 2				

The above result shown in table 4 demonstrates that model summary result shows R values, R square values, its R rate is 0.502 the R square value is 0.252 is shows that 25% respectively. The adjusted R square rate is 16% the standard error of the estimated value is 59% respectively shows positive error value.

The result mentioned in table 5 indicates that the residual model's and regression's sum of square values are shown by the ANOVA test analysis. Men square rates, the F statistic value, and significant

regression and residual model values are also mentioned in the outcome. According to the regression model, there is a 19% significant level of difference between them, with a sum of square rate of 5.379, mean square rate of 1.076, and significant value of 0.019. The results also indicate that the residual model has a sum of square rates of 15.954 which indicates a positive correlation between pathology and mobile health applications. The mean square rates of 0.355 indicate a 35% average value between them

Table 5: Result of ANOVA^a

ANOVA ^a						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	5.379	5	1.076	3.035	.019 ^b
	Residual	15.954	45	.355		
	Total	21.333	50			

a. Dependent Variable: Enhancing Pathology Services 2

b. Predictors: (Constant), Patient Engagement 2, Patient Engagement 1, Mobile Health Applications 3, Mobile Health Applications 1, Mobile Health Applications 2

Table 6: Result of Coefficients^a

Coefficients ^a					
Model		Unstandardized Coefficients		Standardized Coefficients	Sig.
		B	Std. Error	Beta	
1	(Constant)	1.770	.458		.000
	Mobile Health Applications 1	-.018	.149	-.018	.903
	Mobile Health Applications 2	-.249	.179	-.219	.170
	Mobile Health Applications 3	.273	.150	.263	.075
	Patient Engagement 1	.077	.144	.075	.595
	Patient Engagement 2	-.179	.154	-.174	.251

a. Dependent Variable: Enhancing Pathology Services 2

The result shown above in table 6 illustrates the relationship between dependent and independent variables in a linear regression study. The results show that each variable's significant values, t statistic, and unstandardised and standardised coefficient values. The primary independent variable result for the mobile health application

indicates that its beta value is -0.018. The 0.149 standard error result indicates that 14% -0.123 is the t statistic rate. Additionally, the fact that its significance level is 0.903 indicates a 90% significant level of association between improving pathology services and mobile health applications. In a similar vein, the results show that mobile health

applications 2 and 3 are both independent variables; their beta values are -0.249 and 0.273. The significant rate of the positive and negative connection is 17% and 7%, respectively, as indicated by the t statistic values of -1.394 and 1.822. Patient engagement is seen as a mediator variable in 1, 2. It demonstrates that the significant level is 0.595 and 0.251, and the standard error values are 0.144 and 0.154, respectively. It reveals a considerable level of agreement between them of 59% and 25%.

Conclusion

Although patient input is sought more frequently in the commercial technology sector, it is typically acquired through pilot testing or focus groups intended to collect confidential data; patient and carer engagement as partners and cocreators of mHealth is uncommon. A few of our patient engagement activities' features probably helped us collect important data. First, a purposeful effort was made to establish a setting that would assist patients' and carers' integration into research by means of activities that focused on the fundamental ideas of patient involvement and were facilitated by a

trained professional. Second, input on categories of information based on our prior work was gathered as well as spontaneous feedback using a combination of general and targeted open-ended questions. Firstly, to ensure accurate memory of their experience and elaboration on the information they did and did not receive as part of their patient-provider interaction, advisory panel members were chosen based on whether they had had heart surgery within the previous two years. Their ability to participate in talks would have improved as a result. Secondly, the advisory panel convened multiple times, giving members the chance to consider the research questions and their personal experiences either by themselves or in conjunction with carers and other supporters during their patient journeys. These reflections were then brought back to enhance the conversation in later meetings. Lastly, given the patients' remarks regarding the potential of the mHealth app to enable carers to be more involved in the patient's journey, the inclusion of patients and their carers on the advisory panel proved to be relevant and presented a range of experiences. After an overview of these aspects of Mobile health applications in pathology labs, we can conclude that it is an important service to mankind with the help of science and technology.

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