Designing an Innovative System for Serving the Population in Hospitals' Emergency Departments

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Abstract: - The purpose of this study is to investigate health care consumers' perceptions of the presence of a smartphone application that provides: (a) information on the waiting time in the Emergency Department (ED), (b) the available medical specializations per hospital, and (c) guidance in emergency instances.The study's sample included 121 people who used health services in the Attica region, regardless of age or gender. The poll was carried out during January and February 2023. The data was analyzed using the statistical application SPSS 26.0. Most participants believe that the suggested smartphone application offers considerable benefits and helps to cut waiting times and give them with better treatment, depending on the condition and specialization of the doctor.

Key-Words: -Emergency department, technology, implementation, patient satisfaction.

1 Introduction

Many health systems have a substantial number of patients who attend emergency departments; in Canada, for example, there are 14 million ED visits each year [1]. As a result, patients face extended wait times, which might influence the public's impression of the healthcare system as a whole. Because of the ED's 24-hour operation, there are high fixed expenditures and smaller profit margins than in other departments [2]. Extended wait times are a common concern among visiting Intensive Care Unit (ICU) patients. It decreases patients' sense of control while increasing their stress and anxiety levels [3].Many initiatives have been implemented to increase patient input into the ED system in the shortest possible time. These strategies include establishing an ED holding area, admitting patients with fast-track services, registering patients in rooms, providing triage consultations, and forming multidisciplinary integrated teams of doctors from

all departments to supervise and implement changes with varying degrees of success [4-8].

The resulting congestion has been shown to cause delays in diagnosis and quick response for three conditions: pneumonia, stroke, and myocardial infarction with ST segment elevation (STEMI). It can also increase the length of stay (LOS). Delays in initiating early therapy have increased mortality among critically sick patients admitted to the intensive care unit. A few Centers for Medicare and Medicaid Services (CMS) have begun monitoring and sharing patient times in the critical care unit on the Hospital Compare website on a quarterly basis [9].

"To provide the safest and highest quality care" was the mission statement for an integrated healthcare system. Enhancing the patient flow within the organization was one strategy to realize this goal.

By providing patients with advance notice of anticipated wait times before to triage and by digitally updating waiting time delays, hospitals may improve patient care. Process improvements in the ED can demonstrate the operational performance of an active average patient wait time in the system; however, two patient wait time paradigms—actual (confirmed) and perceived (subjective) wait times— must be studied in order to achieve patient satisfaction [10]. The perceived wait time varied significantly from the actual wait time encountered by the patient. Recent research examines the psychological aspects of waiting, and perceived waiting time is a greater predictor than actual waiting time [11].

2 Related Work

Recently, several healthcare providers have begun to provide their customers with important information about the potential delay in service delivery. For example, some researchers have attempted to predict future patient wait times using historical data from California Department of Motor Vehicles (DMV) facilities [12]. In another study, customer wait times were assessed during a phone call with a customer service representative at a contact centre [13].

Any information about the waiting time can help to reduce patient uncertainty and anxiety [14]. For example, in a call centre model, informing patients coming to A&E of the estimated waiting time and expected delays reduces the rate of abandoned calls, increasing overall satisfaction [15].

Hospitals are using methods other than announcements to help patients and inform them of delays. More and more American hospitals are informing their patients about waiting times via smartphone apps and on their websites. Over the past five years, the number of Google searches for ICU or hospital wait times has steadily increased, showing that patients are constantly searching for information about these times. A patient's decision to visit a particular hospital is influenced by a variety of criteria, including institutional preference, location, convenience of access, speed of treatment and health insurance coverage [16].

Besides, people are becoming more aware of waiting times after conducting an empirical study that examined historical waiting times in 211 US hospitals [17]. In our previous works various related topics have been researched. In particular, in [18] the Metaverse philosophy is proposed for public services, including hospitals. The security issues of such applications are examined. In [19] effective smartphone usage is examined, which is necessary in case of smartphone applications for hospitals. In [20] the doctor-patient relationship over social media is examined. Trust is a crucial factor for relationships and proper applications to build trust are useful. This paper extends our previous works by proposing a smartphone application that provides: (a) information on the waiting time in the ED, (b) the available medical specialties per hospital and (c) guidance in emergency cases. Also the opinions of health service users regarding the aforementioned application are analyzed.

3 Research Methodology

3.1 Sample of the study

The study sample consisted of 121 patients-users of health services in the region of Attica, regardless of age and gender. The survey was conducted between January and February 2023.

3.2 Methodology

A special questionnaire was designed for the collection of research data after studying the literature and corresponding studies. The questionnaire included closed-ended and multiple-choice questions. In the first part, there were questions related to demographic data such as gender and age, and in the second part, the questions were exclusively related to the services provided, patients' satisfaction with them, and exploring perceptions about the use of the new application. The questionnaire was sent electronically and was completed via an online form by people who had visited the ICUs at least in the last year.

Using the Kolmogorov-Smirnov criterion, the distributions of the quantitative variables were

tested for the normality of their distribution. For those that were normally distributed, means and standard deviations (SD) were used to describe them, while for those that were not normally distributed, median and inter-quartile ranges were also used. Absolute (N) and relative (%) frequencies were used to describe the qualitative variables. Pearson's χ^2 test or Fisher's test were used to compare proportions where necessary.

Student's t-test was used to compare quantitative Variable between two groups. The non-parametric Mann-Whitney criterion was used to compare ordinal variables between two groups. Spearman's correlation coefficient (rho) was used to test the relationship between two quantitative variables. Linear regression analysis with a stepwise inclusion/exclusion procedure was used to find independent factors associated with satisfaction and benefit scores from which dependence coefficients (β) and their standard errors (standard errors = SE) were obtained. To find independent factors associated with the desire to have an application that would provide information on waiting time and on-call times, logistic regression analysis was performed using the stepwise inclusion/exclusion procedure and obtained relative odds ratios (ORs) with their 95% confidence intervals (95% CIs).

The internal reliability of the questionnaires was tested using Cronbach's α coefficient. The significance levels are two-sided, and the statistical significance was set at 0.05. The statistical program SPSS 26.0 was used for the analysis.

4 Results

The sample consisted of 121 people with a mean age of 41 years (SD = 12.7 years). 71.1% of the participants were women, and 57% were married or cohabiting. 62% of participants had public insurance, and 29.8% had both public and private insurance. 34.7% of the participants had very good knowledge of computer usage, while another 35.5% had good knowledge. Also, 43% of the participants had good fluency in using applications, while 30.6% had very good fluency.

91.7% of the participants have visited the ED in an emergency. 11.6% of the participants had to make a phone call to the emergency department in order to get information, and in 78.6% of the cases, someone picked them up. 45.5% of those who

called and got through were somewhat satisfied, while 54.5% of those who answered were fairly satisfied.

The waiting time for examination was 1-3 hours for 53.7% of the sample, while 39.7% of the participants had a 30 to 60-minute wait for the specialty that required a visit to the ICU from the time of their first evaluation by triage or screening. Still, 1-3 hours was the expected waiting time for results for 57.9% of the participants. 76.9% of participants felt that both the waiting time for service and the waiting time for the specialty of interest needed immediate improvement in service delivery in the emergency department.

The range of satisfaction regarding facilities, waiting time and services, rates was from 19.8% to 65.3%. In particular, 65.3% of participants expressed some satisfaction with the behavior of the nursing staff. Nonetheless, 55.4% of people expressed satisfaction or satisfaction with the team's readiness and willingness to serve, and 58.7% of individuals expressed mild satisfaction or satisfaction with the behavior of the medical staff (Figure 1).
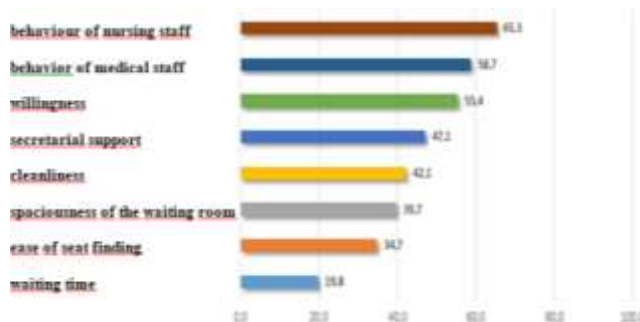
Fig. 1: Evaluation of satisfaction regarding facilities, waiting time and services, provided in the EDs

The table below provides data regarding the participants' desire for an app that would facilitate their visit to the ED (Table 1). Thus, it emerged that 94.2% of the participants would like to have the possibility to be informed about the on-call times of the hospitals through an application installed on their smart phone or tablet, and 95% would like to have the possibility to be informed about the waiting time regarding the specialty of the doctor they are interested in at the hospitals on call through

an application installed on their smart phone or tablet. 83.5% of the participants believed that such an app would offer other benefits to patients.

Table 1.*Assessment of the desire to have an online application*

		N	%
Would you like to be able to get information about hospital on-call times through an app installed on your smartphone or tablet?	No	7	5.8
	Yes	114	94.2
Would you like to be able to	No	6	5.0
be informed about the waiting time for the specialty of the doctor you are interested in at the hospitals on duty, through an application installed on your smartphone or tablet?	Yes	115	95.0
Do you think such an application would offer other benefits to patients (apart from reducing waiting times)?	No	5	4.1
	Yes	101	83.5
	Do not know/ No answer	15	12.4

Table 2.*Expected benefits from the existence of an online application*

	Not at all	Hardly	Moderate	Very	Very much	Very/Very much
Such an application, how much do you think:	N (%)	N (%)	N (%)	N (%)	N (%)	
Would reduce the waiting time when visiting the ED?	1 (0.8)	18 (14.9)	24 (19.8)	49 (40.5)	29 (24)	64.5
Would reduce the paperwork when visiting the ED?	12 (9.9)	18 (14.9)	25 (20.7)	30 (24.8)	36 (29.8)	54.5
Would improve the quality of service when visiting the ED?	5 (4.1)	17 (14)	25 (20.7)	44 (36.4)	30 (24.8)	61.2
Would reduce the inconvenience of a visit to the emergency room?	2 (1.7)	17 (14)	20 (16.5)	40 (33.1)	42 (34.7)	67.8

Table 3. *Correlation of satisfaction scores with demographic characteristics of participants*

		Satisfaction rating (%)		P Student's t-test
		Mean value	SD	
Sex	**Men**	57,68	23,32	0,524
	Women	54,47	25,68	
Married	**No**	56,85	24,50	0,580
	Yes	54,30	25,43	
Private Insurance	**No**	56,25	23,48	0,609
	Yes	53,79	27,77	
The reason of visiting ED was:	**Critical**	54,22	24,24	0,085
	Scheduled	68,44	30,35	
Did you call before visiting for more information?	**No**	53,94	24,70	0,076
	Yes	66,52	25,01	

67.8% of the participants believed that such an application would greatly or very much reduce the inconvenience during the visit to the ED. 61.2% of the participants believed that such an application would greatly or very much improve the quality of services during the ED visit, and 64.5% believed that it would greatly or very much reduce the waiting time during the ED visit. 54.5% of the participants believed that such an implementation would very much reduce paperwork during the visit to the ED (Table 2).

86.8% of participants thought that the new application's health services would benefit. 92.6% of the participants would like the application to offer the ability to find the closest ambulance and its waiting time using real-time GPS, and 96.7% of the participants would like the application to direct them, based on their reported health problems, to alternative primary health care facilities other than public hospital emergency departments.

76% of the participants wanted to use the program only as visitors, and 89.7% wanted to register an account so that the application could keep track of their searches. 88.4% of the participants said they had submitted online requests using the services provided by other state agencies, and 82.2% said this would make it simpler to use this program. Following that, the satisfaction ratings were compared to participant demographics and items pertaining to their ED visit. The satisfaction ratings of the participants are displayed in Table 3, together with information about their ED visit and demographics. According to these results, it was discovered that there was no discernible difference between the participants' satisfaction levels (p > 0.05) (Table 3).

The satisfaction score was then used as the dependent variable in a multivariate linear regression, with the participant's demographic information and information on their ED visit serving as the independent variables. The following table's results were discovered through the use of the stepwise inclusion-subtraction method (Table 4).

Table 4. *Multivariate linear regression*

	β+	SE++	P
Waiting time for examination	-12,63	2,90	<0,001
How long did you have to wait for the specialty you needed to visit the ED from the time you were first assessed by triage/screening?	-7,98	2,25	0,001

+coefficient of dependence
++coefficient standard error

Table 5. *Multivariate regression 2*

	β+	SE++	P
Age	-0,43	0,20	0,031
How would you describe your fluency in using apps on your mobile or tablet?	6,62	3,03	0,031

+coefficient of dependence
++coefficient standard error

There was an independent relationship observed between the participants' satisfaction levels and the waiting times for screening and the necessary specialty. In particular:
- A longer screening wait time was linked to noticeably lower satisfaction.
- Significantly lower satisfaction was linked to longer wait times between screening and the required specialist.

The benefit score was then used as the dependent variable in a multivariate linear regression, with the participant's demographic information and information on their ED visit serving as the independent factors. Stepwise inclusion-subtraction was used to arrive at the following table's results (Table 5).

It was discovered that the participants' benefit scores were independently correlated with their age and level of app fluency. In particular:
- Older age was associated with significantly fewer benefits.
- Greater fluency in using apps was associated with significantly more benefits.

5 Discussion

The ED is a hospital department that faces unique difficulties and unanticipated outcomes, including longer wait times and patient dissatisfaction, higher expenses, a rise in

medical errors, a rise in violent incidents, a disruption in medical services, and an increase in patient mortality. The Emergency Department demands extremely careful planning of both medical services and financial resources in comparison to other hospital departments. Over the past twenty years, ED congestion has spread throughout the world and grown into a complex problem that affects everyone's ability to deliver timely, safe, and high-quality healthcare (administrative, ancillary, and medical staff). In order to support the services offered and increase patient satisfaction, an extremely well-designed service system for the ED population would be crucial [21].

In the current study, it was suggested to use an application that would shorten ED wait times and provide major advantages in terms of prompt care and immediate patient treatment. Based on the study's findings, participants thought that this kind of application was helpful. According to the correlations found, it seems that certain criteria, such as how long a patient had to wait for their ED visit or what specialty they needed to be tested for, had an impact on how satisfied a user is. It is important to note at this point that women made up the majority of the convenience sample. The method used to gather the questionnaire had no control over the gender of the respondent. Moreover, women are more likely than men to agree to participate in surveys globally, which could account for this finding.

Similar research indicates that the quality of information provided in health services in emergency departments (EDs) can be enhanced by a well-designed information system that is user-friendly and customized to meet the demands of users [22]–[25]. Patient satisfaction with emergency department (ED) care services is influenced by waiting times [26], [27].

In a recent study at a university hospital in Geneva, it was shown that an application well accepted by health service users such as PIMPmyHospital could help reduce waiting times in the ED and increase satisfaction. According to this app, through push notifications on the mobile phone, it allows

health caregivers to avoid sacrificing their time to look for laboratory results and obtain them immediately, wherever they are at the point of care. It has been suggested that smart phone use is preferable to using electronic whiteboard icons to communicate laboratory test results, as otherwise, this forces healthcare professionals to access mainly whiteboard information on permanent static screens [28].

This has the potential to considerably reduce the overall ED-LOS for hospital admission or discharge by accelerating the delivery of emergency treatment. Pushing alerts for a rapid influenza test to ED physicians, for example, shortened the time it required to implement an isolation order, transfer the patient to an inpatient facility, and reduce the ED-LOS by about one hour [29].

Many scholarly publications have also looked into how warning signals alter key laboratory outcomes. The majority of these warnings have a beneficial influence on patient care and a significant decrease in the time gap between the availability of laboratory data and clinician decision-making [30–32].

Another characteristic that showed to be crucial in terms of willingness to utilize the smart app and possible advantages was youthful age. That is, participants believed that an app such as this would benefit patients in ways other than reducing wait times, and their age at this belief was much lower. In particular, the older participants were, the less likely they were to believe that an app would offer benefits beyond shorter wait times; on the other hand, the more advantages participants thought an app would offer, the more computer-literate and at ease they were with using apps, and the longer they waited for the test. Considering how accustomed younger age groups are to using technology, this makes sense.

6 Conclusion

Finding solutions that work within the constraints of the present and the capacities of health systems is prompted by the need to enhance patient access to the emergency room and decrease wait times. Tele-health and automatic alerting apps are now part of the growing use of technology and dependable

systems and software, which are essential instruments for enhancing the nation's healthcare system and patient happiness. The idea of e-Health has gained significant traction in recent years and has been formally accepted by the health authorities of most nations in the world, including Greece.The primary goal is to employ technology to meet patient requirements by providing safe, valid, fair, and dependable information.

The following are conditions that must be met before using novel technologies: 1) training; 2) access to the required technology; and 3) funding from qualified healthcare organizations. The public's access, satisfaction with, and flexibility with healthcare will all be enhanced by this. Nonetheless, certain inquiries remain unresolved, including those concerning the efficacy, dependability, and security of the suggested technologies. Before creating an inventive digital product, the solutions can only be found through thorough and well-organized scientific investigations with a sizable sample of patients.

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