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Research Article

Smart Phone App eMediCall™ Usability and Its Impact on the Clinical Communication among Nursing Home Healthcare Providers and Nurses

Shaista Ahmed[1], MD, MPH; Halima Amjad[1], MD, MPH; Qian-Li Xue[1,2,3], PhD; Matthew McNabney[1], MD; Michele Bellantoni[1], MD, CMD; Fatima Sheikh[1], MD, MPH.

[1]Department of Medicine Division of Geriatrics and Gerontology, Johns Hopkins School of Medicine, Baltimore, Maryland, USA.

[2]Johns Hopkins Center on Aging and Health, Johns Hopkins Medical Institutions, Baltimore, Maryland, USA.

[3]Departments of Biostatistics and Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA.

[*]**Corresponding author:** Shaista U Ahmed, Assistant Professor, Department of Medicine Division Of Geriatrics and Gerontology, Johns Hopkins School of Medicine. Mason F Lord Building center tower, Suite 2200, 5200 Eastern Avenue. Email: sahmed49@jh.edu Phone # 410-550-8112

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Abstract

Background: Accurate and timely interprofessional communication is a prerequisite for safe patient management in the nursing homes (NH). Traditional methods of communication are often considered inadequate. The use of smart phone applications has transformed many areas of clinical practice but there is paucity of literature addressing use of smart phone applications in NH setting. The aim of this study was to determine the impact of eMediCall™, a smartphone application (app), by eliciting perceptions of healthcare providers (HCP) and nurses on usability and clinical communication in nursing homes (NH). **Methods:** We conducted a quality improvement project using questionnaire survey to elicit perceptions of efficacy of eMediCall™ app use in improving communication between HCP and nurses at three nursing homes in Maryland. Data was analyzed using simple descriptive statistics and Factor analysis was used to assess the dimensionality and internal construct validity of the eMediCall™ efficacy scale developed for this study. Frequency distribution of survey item responses from the two respondent groups were compared using Fisher's exact test. **Results:** Fifty-one staff members (33 nurses and 18 HCPs) completed the survey. Factor analysis revealed two conceptual factors influencing survey responses: usability and clinical communication (correlation coefficient = 0.67). **Conclusion:** Nurses were more likely to agree that eMediCall™ messages removes barriers to language. HCPs reported that the app reduced frustration related to unclear communication. Both agreed that the app enhanced clinical communication, and facilitated provision of patientcare. Asynchronous communication using smartphone app such as eMediCall™ can have a positive impact on perceptions of nurse-HCP communication.

Keywords: Nursing home communications, physician-nursing relationships, smart phone or mobile phone apps for healthcare communications, patient safety.

Background and Significance

Effective interprofessional communication is critical for delivery of safe patientcare [1].Incomplete interprofessional communications can lead to medical errors and adverse events in healthcare settings [2]. Nursing homes (NH), as well as other healthcare settings such as operating rooms and intensive care units (ICU), have high vulnerability to adverse events from poor nurse-physician communication, including preventable hospitalizations [2-5]. Interprofessional communication is the second safety goal after correct identification of the patient in the Joint Commission's 2020 National Patient Safety Goals for Long-Term Care (LTC) [6]. Poor nurse-healthcare provider (HCP) communication can also lead to low work satisfaction among HCPs and nurses [1,2].

Communication in the nursing homes is complex due to the healthcare setup in NH – nurses work in shifts, HCP may have variable NH rounding schedules, and depending upon the time of the day when laboratory tests are reported to the HCP, nurse-HCP communication may occur more frequently during specific hours of the day than at other times. Therefore, face-to- face interaction may be limited in NH. Although traditional methods of communication between nurses and HCPs in NHs have been verbal (face-to face or over the phone) and/or written (pages, e-mails, or fax) but most often non-face-to-face communication occurs during after-hours and on weekends when HCPs are not in the facility [5]. Synchronous communication via telephone is a common method used in NHs. It provides simultaneous exchange of information but can cause time burden, frustration, and frequent interruptions in work or personal activities [7,8]. Similarly, communication via pages leads to interruptions for HCP, with resultant distraction from the

Primary task and cognitive overload [9,10]. Multitasking to tackle frequent interruptions can lead to medical errors and compromise patientcare [11].

Currently, nurses and HCP both perceive multiple barriers to effective communication. Nurses reports lack of timely HCP response, inadequate time to discuss clinical issues, lack of professionalism or trust, language barriers, and inadequate collaboration [5]. Barriers reported by HCPs include lack of nurses' preparedness or competency to report patient-related issues while nurses reported lack of interest and professional respect [7]. On the other hand, better communication and information exchange among the NH staff leads to improved decision- making, which reduces the number of residents transferred to the hospital [12].

Advancement in the digital technology has introduced new channels of communication to improve efficiency and control cost [13]. It ranges from cell phone text messages, to advanced digital devices and smartphone applications, with 2- way camera, interactive video calls, wireless emails, web-cams, secure chat rooms, online forums and other smartphone applications [7,13,14].

Smartphones offer Asynchronous Communication (AC) tools to share information [14,15]. AC is separated by time, usually in the form of text messages and emails[15]. It is considered less interruptive and is a preferred method for non-urgent situations[15]. Hospitals have adopted smartphone applications to allow sensitive patient health information (PHI), in emergency rooms, medical units and ICUs to be shared in a timely manner, overcoming a shortcoming with the traditional modalities of phone/pager [2,10,16]. Such structured communication methods provide benefits of improved patient care, team work and job satisfaction [17]. Smartphone applications have emerged as potentially useful tool in patientcare and mobile clinical communication in diverse healthcare setting, [16] it is still relatively new phenomenon in NHs. To our knowledge, there are no prior studies that specifically investigated this mode of communication.

Objective

In this study, we examined the perceived impact of a smartphone app, eMediCall™ in three NHs by survey questionnaire. Established in 2012, eMediCall™ was specifically designed for LTC to provide communication that was Health Insurance Portability and Accountability Act (HIPAA) compliant.18 With eMediCall™ a nurse generates a patient-related message and labels it as emergent, urgent, or routine. HCP receives an alert and in response to the message HCP can give "orders", ask clarifying questions, or call the nurse directly.

Materials and Methods

Research Design

eMediCall™ was introduced to many NHs in Maryland in 2015. We recruited nurses and HCPs from three NH facilities where this app is used. HCPs included physicians, nurse practitioners and physician assistants. Nurses included licensed practical nurses and registered nurses. We created survey questions based on the common themes noted by the nurses and HCP of three NH through informal discussions. The questions that were included in the final version of the survey included respondent demographic details and questions to elicit perceptions of nurses and HCP on aspects of usability and clinical communication of the app (Table 3). We defined "Usability" of this application as capacity to allow its users to perform the intended tasks with ease. Usability may reflect effectiveness, efficiency, satisfaction, usefulness, aesthetic, learnability, simplicity, intuitiveness, understandable, and attractiveness [19]. We focused on usefulness, understandability, and simplicity to reflect on app usability.

We defined "Clinical Communication" as any exchange of clinical information related to patientcare. The aspects of clinical communication surveyed included; response time, prioritization of messages, data sharing, patientcare, and social interaction. Responses were rated on 5-point Likert scale, with 1 (strongly disagree), 3 (neutral) to 5 (strongly agree). Project was approved by our Institutional Review Board. Participation in survey was voluntary, and agreement to participate was considered as consent to this study.

Statistical Methods

Demographic data was summarized by service role (HCP vs. nurse), followed by two- step statistical analysis of the survey questions. Licensed practitioner nurses and registered nurses were included in "nurse" category.

First, principal component analysis (PCA) was used to assess the dimensionality (i.e., content domains) of survey scale based on patterns of the correlations between different survey items. Exploratory Factor Analysis (EFA) was used to assess the dimensionality and internal consistency of the eMediCall™ efficacy scale. The number of factors to extract was selected via principal component analysis and based on "eigenvalue-greater-than-1" rule, percentage variance explained, and the parallel test. To accommodate the discrete scale of item responses, polychoric correlation matrix was used for the EFA. The EFA was conducted via a weighted least square mean and variance estimator and the GEOMIN-rotated loadings were presented to aid interpretation.

We further assessed the internal construct validity of the scale by conducting confirmatory factor analysis (CFA) based on the EFA results. Adequacy of model fit was assessed using the Chi-square test of model fit (>0.05), Comparative Fit Index (CFI, >0.90), the Tucker-Lewis Index (TLI, >0.90), and the root mean square error of approximation (RMSEA, <0.05), and Standardized Root Mean Square Residual (SRMR, <0.08) or Weighted Root Mean Square Residual (WRMR, <1). Modification indices were used to identify parameter constraints (e.g., constraining a loading of a particular factor indicator to zero in the CFA) that had the most influence on the fit statistics of the CFA model. The PCA was fit using STATA version 15.0 and the EFAs and CFAs were fit using MPLUS version [8].

In the second step, frequency distribution of item responses from the two groups (HCP and nurses) were compared using the Fisher's exact test.

Results

Survey was given to 100 individuals and 18 HCPs, and 33 nurses responded to the survey with response rate of 51%. From the survey results noted that 49% of respondents were using the eMediCall™ app for more than a year (Table 1).

Demographic Information		HCP (n=18)		Nurses(n=33)	
		Count	%	Count	%
Age	18-25 years	0	0	1	3
	26-44	12	67	13	39
	45-65	5	28	17	52
	➢ 65	1	5	1	3
	Missing	0	0	1	3
Gender	Female	16	89	29	88
	Male	2	11	3	9
	Missing	0	0	1	3
Race	Non-Hispanic White	7	39	4	12
	Hispanic	0	0	2	6
	Black	5	28	24	73
	Asian / Pacific Islander	5	28	2	6
	American Indian	1	5	0	0
	Missing	0	0	1	3
Duration of eMediCall™ app use	0-5 years	11	61	10	30
	6-10 years	3	17	18	55
	>10 years	4	22	0	0
	Missing	0	0	5	15
English as firstlanguage	Yes	14	78	22	67
	No	4	22	9	27
	Missing	0	0	2	6
HCP: healthcare provider; n: Number of respondents					

Table 1: Demographic Characteristics of Survey Respondents.

Principal component analysis identified three principal components with eigenvalue greater than 1 that collectively explained 76% of the variance in the 19-item scale. The parallel test on the other hand identified one dominating principal component. Given that the second principal component accounted for almost 10% of the total variance, we conducted exploratory factor analysis with both one and two factors (Table 2).

	Exploratory Factor Analysis					Confirmatory Factor Analysis		
Item#	**1-Factor Model**		**2-Factor Model**			**2-Factor Model**		
	Loading	**Uniqueness**	**Factor 1 Loading**	**Factor 2 Loading**	**Uniqueness**	**Factor 1 Loading**	**Factor 2 Loading**	**Uniqueness**
Q1	0.752*	0.435	0.001	0.845*	0.285		0.783*	0.387
Q2	0.811*	0.342	0.09	0.825*	0.211		0.848*	0.280
Q3	0.761*	0.420	0.780*	0.017	0.373	0.774*		0.402
Q4	0.807*	0.349	0.844*	-0.004	0.293	0.820*		0.328
Q5	0.923*	0.149	0.863*	0.102	0.128	0.930*		0.135
Q6	0.868*	0.247	0.986*	-0.116	0.167	0.875*		0.234
Q7	0.855*	0.270	0.400*	0.557*	0.234		0.895*	0.200
Q8	0.806*	0.350	0.944*	-0.137	0.263	0.816*		0.334
Q9	0.784*	0.386	0.906*	-0.123	0.313	0.790*		0.376
Q10	0.772*	0.403	0.533*	0.314*	0.394	0.785*		0.384
Q11	0.863*	0.255	0.615*	0.327*	0.247	0.875*		0.234
Q12	0.775*	0.400	0.649*	0.183	0.387	0.786*		0.383
Q13	0.854*	0.270	0.849*	0.038	0.236	0.862*		0.257
Q14	0.798*	0.364	0.505*	0.374*	0.353	0.810*		0.344
Q15	0.883*	0.221	0.666*	0.291*	0.213	0.893*		0.203
Q16	0.953*	0.091	0.719*	0.319*	0.077	0.968*		0.062
Q17	0.888*	0.211	0.323*	0.675*	0.150		0.931*	0.133
Q18	0.907*	0.177	0.353*	0.663*	0.124		0.951*	0.096
Q19	0.646*	0.582	-0.165	0.919*	0.330	-0.824*	1.512*	0.238
Goodness-of-Fit								
Chi- square Test	306.3 (d.f. 19) P-value<0.001		239.9 (d.f. 134) P-value<0.001			250.1 (d.f. 150) P-value<0.001		
RMSEA	0.141 (0.118, 0.164)		0.124 (0.099, 0.150)			0.114 (0.089, 0.139)		
CFI	0.952		0.967			0.969		
TLI	0.946		0.958			0.964		
SRMR	0.093		0.070			NA		
WRMR			NA			0.882		

RMSEA: Root Mean Square Error of Approximation; **CFI:** Comparative Fit Index; **TLI:** Tucker- Lewis Index; **SRMR:** Standardized Root Mean Square Residual; **WRMR:** Weighted Root Mean Square Residual.
* Significant at 5% level # Refer to Table 3 for questionnaire items.

Table 2: Results from exploratory and confirmatory factor analysis (Factor 1 – clinical communication, Factor 2 – usability)

The one-factor and the two-factor model appeared to have largely comparable goodness- of-fit test statistics. The overall fit of the 2-factor model was good based on CFI, TLI, and SRMR. The two-factor model is composed of factors (domains) usability (indicated by items from survey questions [1, 2, 7, 17-19] and clinical communication (indicated by items from survey questions [3-6, 8-16]; and two factors were moderately correlated with a correlation coefficient of 0.67. The loading coefficients in (Table 2) represent the degree of influence of latent factors on their corresponding indicators (i.e., questionnaire items). The percentage of total variance in each item left unexplained by the two factors in the 2-factor model ranged from 13% to 39%, suggesting a nontrivial level of measurement error or other factors that might have influenced the item responses. The results of the CFA are presented in (Table 2) based on a priori mapping (informed by EFA) between items from survey questions [3-6, 8-16, 19] and factor 1 (i.e., clinical communication) and between items from survey questions [1, 2, 7, 17-19] and factor 2 (i.e., usability). Based on examination of the modification indices, the item [19] was allowed to be influenced by both factors; however, the direction of the influence seemed to be in the opposite direction, with a negative correlation with the usability factor and positive correlation with the clinical communication factor. The fit of the model appears to be good based on RMSEA, CFI, TLI, and WRMR (Table 3). Questions 20 and 21 were excluded from final analysis, as they did not correlate to the app's usability and clinical communication.

Domains	Item^	HCP (n=18)			Nurse (n=33)			p- value*
		Agree	Neutral	Disagree	Agree	Neutral	Disagree	
Usability	Q1. Simple to use	36	22.2	5.6	43.25	12.1	6.1	0.606
	Q2. Perform desired function	39	16.7	5.6	36	18.8	9.4	0.744
	Q7. Reduce Language barriers	32.4	23.5	5.9	42.4	3.0	6.1	0.012
	Q17. Reduced frustration	26.5	23.5	11.8	32.3	19.4	16.1	0.012
	Q18.Mutual Respect	26.6	35.3	5.9	25.8	29.0	9.7	0.818
Clinical Communications	Q3. Enable user to stay mobile	43.8	12.5	0	37.1	12.9	6.5	0.853
	Q4. Less Effort	33.3	11.1	11.1	31.3	12.5	25.1	0.939
	Q5. Time saving	35.3	5.9	11.8	26.6	21.9	12.5	0.386
	Q6. Less interruptions	33.4	16.7	16.7	27.3	24.2	15.2	0.392
	Q8.HCP urgent response time	29.3	11.8	14.7	22.6	22.6	16.1	0.178
	Q9. HCP routine response time	34.4	12.5	18.8	26.7	16.7	15	0.186
	Q10. Information sharing	23.6	35.3	17.7	36.4	12.1	7.6	0.063
	Q11.Message Prioritization	38.9	5.6	8.4	30.4	25.0	7.2	0.320
	Q12. Clinical data	34.4	18.8	12.5	28.1	25.0	9.4	0.317
	Q13. Timely patient care	33.4	27.8	5.6	23.5	31.3	11	0.239
	Q14. Communication storage	41.2	11.8	5.9	32.9	18.8	15.6	0.512
	Q15. New way to working	36.2	16.7	5.6	31.3	18.8	9.4	0.438
	Q16. Nurse's satisfaction	33.4	25.0	8.3	25.8	32.3	8.1	0.843
	Q19, Reduce social interactions	21.9	18.8	31.3	37.6	12.5	14.6	0.704

Abbreviated questions, detailed questions are listed under the Appendix. *Based on Fisher's exact test HCP= Healthcare Provider; n= Total number of respondents from that group

Table 3: eMediCall™ Survey Questions and Summary survey item response frequencies by role

Usability

Nurses were more likely than HCPs to agree that eMediCall™ messages were easily understood and barriers to language were removed (question #7, p-value 0.012). HCPs were more likely to agree that the app reduced frustration related to unclear communication (question #17, p-value 0.012). Both groups agreed that the app software was simple to operate, performed desired functions with minimal malfunction, and helped to create understanding and mutual respect in communication.

Clinical Communication

Nurses were more likely to agree that eMediCall™ app helped share adequate information to make clinical decisions, but the difference was not statistically significant (question 10, p=0.063).

Nurses and HCPs agreed that the app enabled users to stay mobile, 2-way communication required less effort, was time efficient, caused less interruptions, helped create mutual respect in communication, improved HCP response time, and helped with prioritization of messages. They both expressed that app's added features of sharing laboratory results, vital signs, clinical status, and radiology, helped deliver better patientcare in a timely manner. They liked features of storage and retrieval of information. Respondents agreed that it enabled them to work in new ways as healthcare team and increased nurses' satisfaction.

Discussion

Our study shows that smartphone apps such as eMediCall™ can have a positive impact on perceptions of nurse-HCP communication in a NH setting in aspects of usability of the app and facilitation of clinical communication. Despite being a small study, our results add to the growing literature that supports the use of smartphone in healthcare. Smartphone apps like eMediCall in NH setting can improve communication by offering a platform for clear and accurate communication among healthcare providers, the option of prioritizing message can reduce unnecessary interruptions and sharing secured patient information can expedite clinical decisions resulting in timely patientcare. Smartphone apps in NH setting can also improve perceptions of nurses' satisfaction and mutual respect with HCP.

Based on the statistical analysis the highest correlation for this app was related to its usability, which we believe makes it an attractive tool to improve interprofessional communication in a NH setting. Nurses suggested embedding the PHI from electronic medical record (EMR) directly into the eMediCall™ messages which can further improve usability of such smartphone apps.

Limitations

This study has several limitations. It was limited to three nursing homes in Maryland. Reponses reflect subjective experiences and perceptions of the respondent's rather than objective or measured outcomes. Additionally, the sample size was small, and the number of HCP respondents was disproportionately less as compared to the nurses, which may limit generalizability of the results. Lastly, this study was not designed to evaluate patientcare outcomes.

Conclusion

Effective and efficient nurse-HCP communication is a key to good patientcare. There is a paucity of research about role of smartphone communication apps in the NH setting[20].The NH environment is unique in terms of limited face-to face interaction between nurses and HCP, with most of the communication occurring distantly either over the phone or by email. Barriers to an effective communication differs in NH as comparted to an acute care setting. Our study shows that Asynchronous communication via eMedical™ can improve perceptions of effective communication by secure sharing of PHI, enhancing clinical communication, expediting clinical decisions, and facilitating timeliness of patientcare. This mode of communication also increases nurses' perceived satisfaction with HCP, which has been barrier for effective communication with traditional methods.

Next steps include, study objective measures of communication, and patient outcomes associated with nurse-HCP communication in NH setting. Furthermore, research is needed to explore usability and clinical communication of other smartphone apps in NH.

For wider application of this app, future studies may explore role of organizational culture and physical location of the NH (urban vs. rural).

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