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The Use of a Kiosk-Model Bilingual Self-Triage System in the Pediatric Emergency Department

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Background: Streamlining the triage process is the key in improving emergency department (ED) workflow. Our objective was to determine if parents of pediatric ED patients in, low-literacy, inner-city hospital, who used the audio-assisted bilingual (English/Spanish) self-triage kiosk, were able to enter their child's medical history data using a touch screen panel with greater speed and accuracy than routine nurse-initiated triage.

Methods: Parent/child dyads visiting the pediatric ED for nonurgent conditions (February to April 2012) were randomized prospectively to self-triage kiosk group (n = 200) and standard nurse triage group (n = 200). Both groups underwent routine nurse-initiated triage that included verbal elicitation of basic medical history and manual entry into patients' electronic medical records.

Results: The kiosk user was a parent in 88.5% of the cases, a patient (range, 11–17 years) in 9.5% of the cases, and a proxy user (sibling or friend) in 2% of the cases. Language choice for kiosk use was equally distributed (English vs Spanish, 50.5% vs 49.5%). The mean (SD) time to enter medical history data by the kiosk group was significantly shorter than the standard nurse triage group (94.38 [38.61] vs 126.72 [62.61] seconds; $P < 0.001$). Significant inverse relationship was observed between parent education level and kiosk usage time ($r = -0.26$; $P < 0.001$). The mean inaccuracies were significantly lower for kiosk group ($P < 0.05$) in areas of medical, medication and immunization histories, and total discrepancy score.

Conclusions: Kiosk triage enabled users to enter basic medical triage history data quickly and accurately in an ED setting with future potential for its wider use in improving ED workflow efficiency.

Key Words: triage, kiosk, medical history

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Emergency department (ED) overcrowding has been shown to have a significant impact on various clinical outcomes; it also affects ED workflow by interfering with important processes of care.[1–4] The issue of overcrowding and hindrance to ED workflows in general may make children more vulnerable to adverse events such as medication errors.[5] Systematic triage of pediatric patients in the ED has been identified as an effective tool for overcoming problems related to ED overcrowding.[6] Triage decision making is a complex process generally based on 3 key elements—eliciting and recording of current disease history, performing a brief clinical assessment, and obtaining and documenting of vital signs.[7] With advances in information technology, it may be possible to streamline the triage process by enabling patients to self-report portions of their medical history directly into their electronic medical records (EMR).[8] This is an important step in reducing triage time because the collection and recording of extant patient information can proceed despite ED workforce issues, such as the need for an interpreter for patients who use English as a second language. To date, no published studies have assessed the utility of using a patient-centered "kiosk" in which a parent/patient inputs presenting complaints and basic medical information to facilitate and expedite the actual triage process.

We hypothesized that the use of an audio-assisted, bilingual (English/Spanish), self-triage kiosk would enable parents or guardians of pediatric patients visiting the ED to self-input their child's basic medical history quickly and accurately. The objectives of this study were to compare the time completion for a set of standard triage questions between kiosk self-triage users and the routine nurse-initiated triage in the pediatric ED setting, to compare the accuracy of medical triage history obtained using the 2 systems, and also to assess patient satisfaction.

METHODS

Study Design

Parent/child dyads presenting to the pediatric ED for a nonurgent condition during the "off-peak" hours of 10:00 A.M. to 3:00 P.M. Monday through Friday during a consecutive 11-week period between February 2012 and April 2012 were enrolled prospectively. The study was approved by the institutional review board of the hospital.

Study Setting

This study was conducted in the pediatric ED of a 449-bed inner-city tertiary care teaching hospital. The pediatric ED serves a predominantly low-socioeconomic, low-literacy, Latino patient population and has an annual volume of approximately 19,000 visits.

Study Subjects

Patients (range, 0–18 years) registering in the pediatric ED and accompanied by a parent/guardian were eligible for enrollment provided that the patient was assigned with an Emergency Severity Index version 3 score of 4 or 5, indicating nonurgent status by the triage nurse. Additional inclusion criteria included the ability of the parent/guardian to communicate in English or Spanish. Incarcerated patients or patients from juvenile detention facilities were excluded from the study.

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Routine Triage Workflow

At the point of first contact on entry into the pediatric ED, the parent/patient is directed to the triage nurse who then conducts a rapid visual-observational assessment (first look) to determine whether a child is "sick" or "not sick" using the Pediatric Assessment Triangle.[9] If a patient is deemed medically stable using the Pediatric Assessment Triangle method, the parent/patient dyad proceeds with registration. Thereafter, patients wait to be called by the triage nurse for a formal triage (Fig. 1). During our study period, the triage nurse determined study eligibility at this time and offered study participation.

Randomization

A bilingual (English/Spanish) research assistant (RA) obtained written informed consent and explained the study process to the parent. Enrolled parents were then randomly assigned to the following: (1) routine nurse-initiated medical history or (2) medical history by kiosk. The RA selected the next sequentially numbered envelope and instructed parents accordingly (Fig. 1). Parent/patient dyads assigned to the routine nurse-initiated triage group proceeded with the routine triage process. The triage nurse elicited a brief medical history that included the following: chief complaint, medical history, prior surgical history, medication history, allergies, and vaccination history; the responses were entered manually on the patient's EMR. This session from initiation of history to conclusion of entry was observed by the RA and timed.

Intervention

Audio-Assisted Touch Screen Triage Kiosk

The self-triage kiosk was stand alone and not connected to the hospital EMR system. It was set up in a secure location in the triage area to ensure privacy. It included a "touch screen" panel on which medical history questions appeared in the same sequence as it routinely appears in the medical history section of the nursing triage summary in the patient's EMR. The introductory screen began with language options, "English" or "Spanish." Triage questions appeared thereafter supplemented by audio prompts (female voice) in the patient's language of choice. At the end of the session, the RA collected a time-stamped printout (in English) of the answers and retained the document for discrepancy rating during a follow-up face-to-face interview with

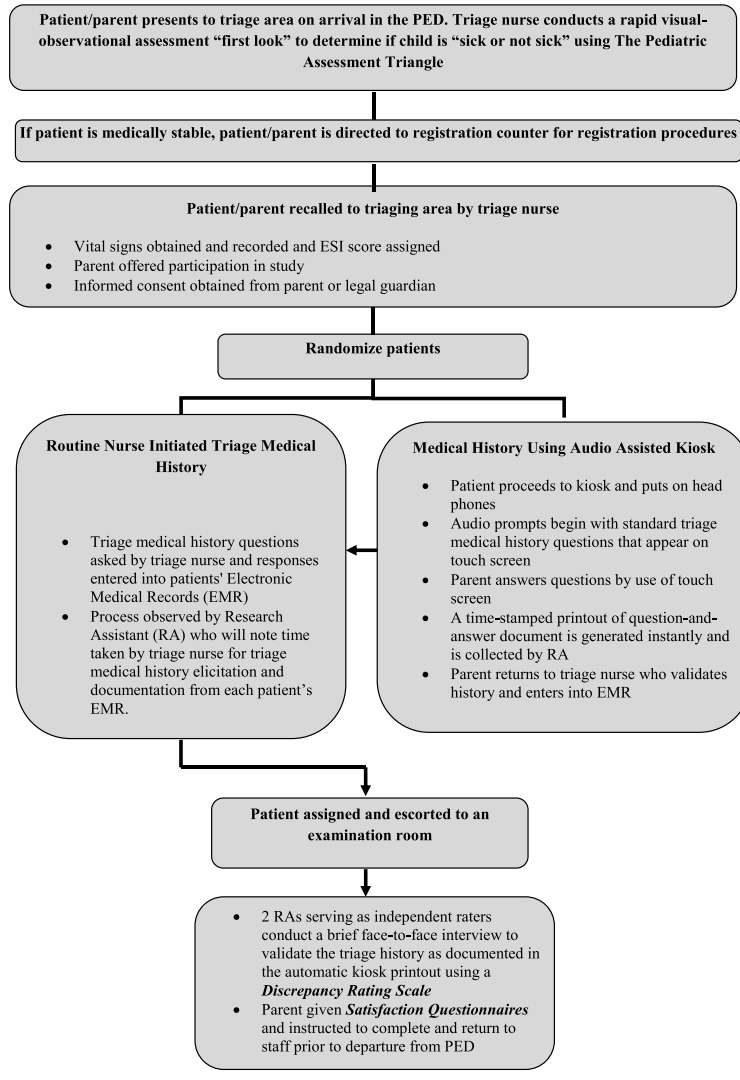

FIGURE 1. Study design flow chart.

the parent/guardian; parents then returned to the triage nurse for completion of routine triage procedure (Fig. 1).

The software application installed in the kiosk was custom developed for this study using Microsoft Visual C# (Microsoft®, Redmond, VA) and Python programming languages (Python Software Foundation, Beaverton, Oreg) by study investigators from College of Technology and Innovation in Arizona State University. Windows Forms Designer was used to create the user interaction elements and English/Spanish bilingual functionality. Microsoft Speech Application Programming Interface was used to create text to speech audio feedback, and touch input was developed using the Microsoft Touch Application Programming Interface.

Usability Testing and Cognitive Task Analysis

Kiosk usability testing was performed to determine design flaws and areas of improvement before study enrollment. Usability testing involved direct observation of actual patients completing the triage questionnaire using the touch screen kiosk (interface). The "thinking aloud" technique where users are encouraged to verbalize their thoughts while using the interface was used; each session was videotaped.[10,11] Members of the investigator technical team reviewed the videotaped sessions (see Video, Supplemental Digital Content 1, http://links.lww.com/PEC/A35). Analyses of user behavior and potential problems with the kiosk interface were identified, a cognitive task analysis was done, and appropriate actions taken to rectify deficiencies were observed.

Measures

Discrepancy Rating

To assess the accuracy of information obtained during the self-initiated kiosk triage and document any discrepancies in medical history, a Discrepancy Rating Scale (Appendix 1, http://links.lww.com/PEC/A39) was designed with the routine nurse-initiated triage serving as the reference standard. The Discrepancy Rating Scale incorporated all 6 elements of the triage history (chief complaint, medical history, prior surgical history, medication history, allergies, and vaccination history). Two RAs approached parents in individual examination room while awaiting clinical evaluation. Each RA independently rated the information and assigned a score (major discrepancy [score 2], minor discrepancy [score 1], and no discrepancy [score 0]) to the 6 different elements after a verbal verification of responses for each element of medical history and tallying them against the answers provided during the kiosk triage process.

Overall Satisfaction/Kiosk Usability

Parent satisfaction with the 2 triage modalities was assessed through a brief bilingual patient satisfaction survey. The survey assessed general satisfaction with triage process and also navigation and usability for kiosk users (Appendix 2a and 2b, http://links.lww.com/PEC/A40).

The primary outcome was difference in time taken to complete the triage medical history questions in the routine nurse-initiated triage versus self-triage kiosk condition. Secondary outcomes included the following: medical information accuracy between the 2 modalities, parent satisfaction with the overall triage process (for all patients), and kiosk usability.

Power Calculation

Sample size was calculated based on the primary outcome of triage time. In a convenience sample of 20 suitable patients studied prospectively before study initiation in the same ED, the mean (SD) time required for routine nurse-initiated triage (excluding vital signs and conduct brief clinical examination time) was 4.8 (1.8) minutes. Using an independent t test with a power of 90% and a 2-tailed α of 0.01 to demonstrate a clinically meaningful difference of 20% in the mean time between nurse-initiated triage and kiosk time, a sample of 180 parent/patient dyads (90 dyads per group) would be required. We decided to recruit double that number, with 200 patients in each group.

Statistical Analysis

All statistical analyses were done using SPSS statistical software (SPSS Inc, Chicago, Ill). Triage time required for the self-triage kiosk and routine nurse-initiated triage was expressed as mean (SD) time in seconds, and differences were compared using an independent t test. A κ statistic and 95% confidence interval were calculated to assess the interrater agreement between the 2 independent raters validating patient medical histories. Descriptive statistics was used to assess parent/patient satisfaction.

RESULTS

Usability Testing Phase

Twenty-two parent/child dyads were recruited during a 1-week period in January 2012 for prestudy usability testing; sociodemographic characteristics of the usability testing population were representative of the final study's 20-fold sample. There was strong correlation ($\alpha = 0.20$) between kiosk completion time and user's education level. The mean (SD) task completion time was 110 (58.7) seconds. Discrepancy results for information accuracy were favorable, with only 2 cases reporting discrepancies; both cases were related to recent medication information. All 22 dyads reported most favorably on a 7-point scale with regard to clarity and readability of questions, learning curve, overall ease of use, and software and system appearance. The investigator team made several interesting observations before and during the usability testing (Table 1).

Project Implementation/Patient Recruitment Phase

A total of 459 parent/child dyads were assessed; 59 (12.9%) dyads refused participation, and 400 dyads were enrolled over an 11-week period (February-April 2012), with 200 dyads randomized to each arm. Ages of participants (parents/legal guardians) ranged from 16 to 62 years (mean [SD], 33[9] years). Patient ages ranged between 2 weeks and 18 years (mean [SD], 6 [5] years). Most (89.3%) parents/legal guardians were females; 82% were Hispanic. The demographic characteristics between the participants randomized to the standard triage arm did not differ from the participants randomized to the kiosk arm (Table 2).

Kiosk Users' Unique Characteristics

Of the 200 dyads randomized to the kiosk group, 88.5% were parent users, whereas 9.5% were patients (range, 11–17 years) themselves who used the kiosk; the remaining 2% of the dyads had a proxy user (sibling or a friend); 50.5% of the participants opted for English, and 49.5% of the participants answered questions in Spanish on the kiosk. Interestingly, only 3 of the 63 dyads who indicated that they spoke English at home used the kiosk in Spanish; however, 12 of the 72 dyads who indicated that Spanish was their primary language used the kiosk in English.

Intervention Results

The mean (SD) time to task completion for kiosk users (94.38 [38.61] seconds) was shorter than the mean time taken by nurse-initiated triage (126.72 [62.61] seconds), and this difference was statistically significant (T value with 331.24; $df = -6.22$;

TABLE 1. Observations During Review of Videotaped Sessions for Usability Testing and Corrective Actions Taken

Observations	Actions Taken
Proxy users	
• Instances where user was not a parent (teen patient or a relative) or a parent along with another user together completed session	• Decision was made to allow proxy users to simulate likely real-time scenario
• Not having headsets for both patient and parent/guardian	• Two headsets (with head phone covers) provided for parent and proxy user/patient
Problems with certain screens	
• Not knowing to press "next" immediately after choosing a language option	• Made "next" button prominent and increased font sizes
• Trying to choose multiple complaints	• Reprogramming done to allow for user to choose multiple complaints on a screen
• Not realizing that there are 2 questions on 1 screen (eg, allergies in tape and latex)	• Audio prompts made to coincide with simultaneous highlighting of questions and choices during prompts
Radio button size	
• Number of times an answer was chosen without registering on kiosk was noted	• Size of radio buttons on touch screen increased to ensure each choice was registered promptly
Timing of each session	
	• Automatic time stamp to document session duration installed
Other observations: user comfort and distractions	
• Mother preparing bottle and feeding baby	• Kiosk table lowered and provision to sit and use kiosk made
• Children wanting to touch the screen	• Small children accompanying parent provided with coloring books and other distractions
• Children being bored while waiting for their parents	

$P < 0.001$). Spanish users took a significantly longer time to complete entering their medical information when compared with English users (mean [SD], 110.5 [37.9] vs 78.6 [32.4] seconds; $P < 0.001$). In the kiosk group, there was a significant inverse relationship between parent education level and kiosk usage time ($r = -0.264$; $P < 0.001$). The standard nurse-initiated triage group, however, did not show a significant correlation between parent education level and triage time ($r = 0.05$). There was also a significant correlation between parent age and kiosk usage time ($r = 0.27$; $P < 0.001$) but no significant relationship between parent sex and kiosk usage time ($r = -0.02$; $P = 0.76$). Independent-sample t tests showed no significant differences in mean time to task completion between parent, patient, and proxy users of the kiosk.

TABLE 2. Demographic Characteristics: Kiosk Users Versus Standard Nurse Triage Participants

Demographic Variables	Kiosk Users (n = 200)	Standard Triage (n = 200)	*P*
Age, mean (SD), y			
• Of parents	33 (8)	33 (9)	0.46
• Of children	6 (5)	6 (6)	0.35
Sex (male), %			
• Of parents	8.5	13.0	0.2
• Of children	54.5	55.5	0.92
Race/ethnicity, %			
• Hispanic	78.0	80.0	0.71
• Caucasian/White	8.0	4.5	0.21
• Black/African American	8.0	11.0	0.39
• American Indian	4.0	3.5	1.0
• Asian	1.5	1.0	0.37
Primary language used at home, %			
• English only	31.5	31.5	1.0
• Spanish only	36.0	35.5	1.0
• Both English and Spanish	30.5	30.5	1.0
• Other language	2.0	2.5	1.0
Education level of parents, %			
• Less than high school	52.0	47.0	0.37
• Completed high school	27.5	29.5	0.74
• College level or higher	20.5	23.5	0.55

κ statistics were calculated between the 2 individual raters for the first 100 dyads enrolled to assess interrater reliability in rating discrepancies in medical information between kiosk and standard participants. All 6 areas, in addition to the discrepancy score, showed statistically significant agreement between the 2 raters for accuracy (Table 3). The surgical history and immunizations were the only 2 areas that showed only substantial agreement ($0.66 \leq \kappa \leq 0.82$) between the 2 raters, whereas the remaining areas all showed nearly perfect agreement ($0.83 \leq \kappa \leq 1.00$).

TABLE 3. Interrater Reliability Assessment for Discrepancy Rating in Medical History Between Kiosk Users and Standard Triage Users

Area	Valid Cases	Kappa Statistic (κ)	Significance
Chief concern	100	0.954	<0.001
Medical history	100	0.936	<0.001
Surgical history	100	0.662	<0.001
Medication history	100	0.827	<0.001
Allergies	100	1.000	<0.001
Immunizations	81*	0.687	<0.001
Total discrepancy rating score	100	0.940	<0.001

*Lack of complete immunization documentation in patient's EMR.

TABLE 4A. Overall Satisfaction With the ED Triage Process Between Kiosk Users (Group 1) and Non Users (Group 2)

	Group 1 (Mean Satisfaction Scores) (n = 200)	Group 2 (Mean Satisfaction Scores) (n = 200)	*P*
Understood questions	5.54 (0.83)	5.38 (0.76)	0.05
Easy to answer	5.62 (0.78)	5.54 (0.78)	0.34
Privacy respected	5.75 (0.62)	5.67 (0.64)	0.18
Overall feelings	5.69 (0.70)	5.55 (0.75)	0.05*

Values are presented as mean (SD).

* refers to P value approaching significance.

Accuracy of Medical History Information

The mean number of inaccuracies was significantly lower for the kiosk group than the standard triage group ($P < 0.05$) in the areas of medical history, medication history, immunization history, and the total discrepancy score.

Overall Satisfaction with Triage

All 400 patients completed a bilingual survey regarding their experience of the overall triage process (Appendix 2a and 2b). Satisfaction was assessed for understanding of the questions, easy of answering, privacy, and overall feelings about the process. The mean scores are summarized in Table 4A. Kiosk users expressed better overall satisfaction with the self-triage process.

Kiosk User Satisfaction

Dyads in the kiosk group also completed a satisfaction survey regarding kiosk usability. Patients rated their kiosk session in 10 specific areas using a 7-point Likert scale (1 = strongly agree; 7 = strongly disagree). Ninety percent or more rated strong satisfaction with kiosk use in all 10 areas (Table 4B).

Kiosk User Feedback

Sixty-five dyads provided feedback. Most (83%) dyads provided generally positive comments regarding accuracy, convenience, and speed of using the kiosk, benefit of having an audio-assisted system, advantages of using a bilingual system, lack of complications, and satisfaction with staff members. Ten percent of dyads had negative comments, including: difficulty using the kiosk with a small child trying to touch the screen, difficulty in choosing answers with the sensitive touch screen, difficulty understanding some of the medical terms, and preferring to speak directly to a health care provider.

DISCUSSION

Approximately 30 million children seek emergency care annually in the United States; pediatric patients have one of the highest ED use rates nationally, and this number has been increasing steadily.[12] In a recent study, an increase in pediatric ED census by 50 patients above the average daily volume of 250 patients increased the total triage time by 6.6 minutes.[13] In our study, parents of pediatric ED patients in a low-literacy, bilingual population were able to enter their child's medical history information faster and with considerable accuracy when compared with standard nurse triage. Although our study kiosk was stand alone, this information could be directly integrated into a patient's EMR in the future. Emergency department triage staff would only need to validate the information already entered before proceeding with other clinically focused triage functions.

Several large health systems have recently begun using self-service medical kiosks to facilitate patient check-in, registration, appointment scheduling, and payment. These "patient-centered" options have claimed to lead to high user satisfaction, a reduction in paperwork, and increased auxiliary personnel efficiencies.[14,15] Among the few studies that have examined patient history data collected directly from parents/patients, results have indicated that the data collected directly from parents/patients may be more accurate than the data collected by physicians and nurses.[8,16] In addition, previous studies using audio computer-assisted self-interviews relative to face-to-face interview techniques have shown audio computer-assisted self-interviews to enhance privacy perception among users and have also proven to be more useful among low-literacy populations as questions are presented both aurally and visually.[17] Audio-assisted prompts in the patient's own language can also overcome miscommunication and valuable time spent on translation. The addition of an automated translation feature that translates the patient testimony into an English transcript (such as in this study) could help ED staff to validate similarly a patient's history in the future before proceeding with other clinically focused triage functions. Enabling patients to attest their medical histories using digital pens is also likely to add significant medicolegal value to the history document. Our study demonstrated that both English and Spanish kiosk users expressed high level of satisfaction with their kiosk use.

Historically, interactive kiosks have been used for providing targeted patient information and education.[18–22] They have also been shown to have favorable acceptance among patients with language and socioeconomic barriers.[23–26] To our knowledge, self-service kiosk use has been limited to activities such as patient education and, in some instances, for registration and payment. In a study at the Portland Veterans Affairs Medical Center, researchers successfully developed and implemented

TABLE 4B. Kiosk User Satisfaction With Various Aspects of Kiosk Usability

Elements of Kiosk Usability	n	Rated 1 (Strong Agreement), %	Rated 2, %	Rated 3, %	Rated 4, %	Rated 5, %	Rated 6, %	Rated 7 (Strong Disagreement), %
Ease of use	200	94.5	3.5	0.5	1.5	0	0	0
Question clarity	200	97.0	2.0	0.5	0.5	0	0	0
Speed of use	200	95.5	3.5	0.5	0.5	0	0	0
Learnability	200	96.0	1.5	0.5	1.0	0	0	0
Error correction	182	90.1	6.0	2.2	1.7	0	0	0
Screen readability	200	95.0	4.0	0	1.0	0	0	0
Audio clarity	186	95.2	2.2	1.1	1.5	0	0	0
Future use	200	92.5	4.0	1.5	1.0	0	0	1.0
Overall satisfaction	200	94.0	3.5	1.5	1.0	0	0	0
Recommend to others	200	92.5	3.0	3.0	1.5	0	0	0

the Automated Patient History Intake Device, a self-service kiosk, to improve the accuracy of medication history by showing patients digital pictures of their medications on record.[27] With the rapid evolution of consumer-based information technology, patients have the opportunity to become collaborative partners in their care.

The ED is a place where transitions in care are frequent, and bridging information gaps during transitions is crucial for ensuring continuity in care and reducing error risk. Streamlining "front-end operations" in an ED using health information technology is very recently being considered an effective strategy in improving quality and reducing costs.[28,29] If successful, this technology could be adopted in any ambulatory setting, urgent care centers, or EDs for lower-acuity patients.

There are some limitations to our study. The current study was designed to include only English- or Spanish-speaking parents. The use of the self-triage kiosk was not tested among other patient subgroups whose communication needs routinely result in longer standard triage times, therefore limiting the generalizability of study results. In addition, this study was limited to touch screen options only; future use of voice recognition soft ware facilitating translation of verbal answers into text format that can be integrated directly into the EMR needs to be studied.

This study suggests the viability of a user-friendly kiosk modality for accurate and reliable self-triage among nonurgent patients in an ED setting. This patient-centric technology is likely to have widespread use in the future, leading to improvement in workflow efficiency and greater patient satisfaction because it provides patients with the opportunity to participate in their own care.

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