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Human-Centered Patient Safety Design of a Mobile Health App for Seizure Management

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SUMMATIVE STATEMENT
This study utilized human-centered design techniques to present a solution to the persisting problems faced by people with epilepsy (PWE). With the goal of improving patient safety and building well-connected health systems while addressing the needs of all stakeholders involved, a concept design and prototype of a mobile health application was proposed.

KEYWORDS: Epilepsy, Seizure Management, mHealth, Human-Centered Design

PROBLEM STATEMENT
Patient safety has always been one of the major concerns of PWE. Epilepsy, a common neurological disorder characterized by recurring seizures, affects over 65 million people worldwide (Zack & Kobau, 2017). Despite its prevalence, there is still a lack of understanding of the detailed pathophysiology of epilepsy and the current treatment and intervention strategies for seizure management are still at its early stages (Stafstrom & Carmant, 2015). To date, even with treatment and medication, it usually takes several years for seizures to be controlled (Ferlisi et al., 2015). PWE are still faced with a high risk of premature death, also known as Sudden Unexpected Death in Epilepsy (SUDEP), caused by serious injuries during seizure occurrences (Surges & Sander, 2012). Moreover, PWE are found to be prone to depression and anxiety which makes them more vulnerable to health-related risks (Scott et al., 2017). Thus, there is an urgent need to provide an efficient and accessible solution, like an mHealth app, to help PWE better manage their seizures, decrease the chances of serious injuries and SUDEP, and help them cope with their day-to-day activities in general.

RESEARCH OBJECTIVE/QUESTION
The present study aims to apply various ergonomic design approaches (Zeng et al., 2010) and provide a holistic solution by bringing the stakeholders' perspective on the design and development of an mHealth intervention for the management of seizures in PWE.

METHODOLOGY
This study is divided into three phases: problem identification, human-centered ideation and iterative design and evaluation (Figure 1). In the first phase, a semi-structured interview was conducted with 11 different stakeholders (5 PWE, 4 guardians, and 2 healthcare professionals). Interview data was subjected to thematic and needs analysis, succesively. The needs or the voice of customer (VOC) extracted from phase I served as the basis for the solution ideation in phase II. In the second phase, personas, scenarios and journey maps were utilized to extract the candidate features for the application. To match the design specifications with the VOC, Quality Function Deployment (QFD) was utilized (Howard et al., 2008; Niku, 2009; Pahl et al., 2007). As a supplement, QFD was paired with Analytic Hierarchy Process (AHP) to abate the variation and subjectivity of

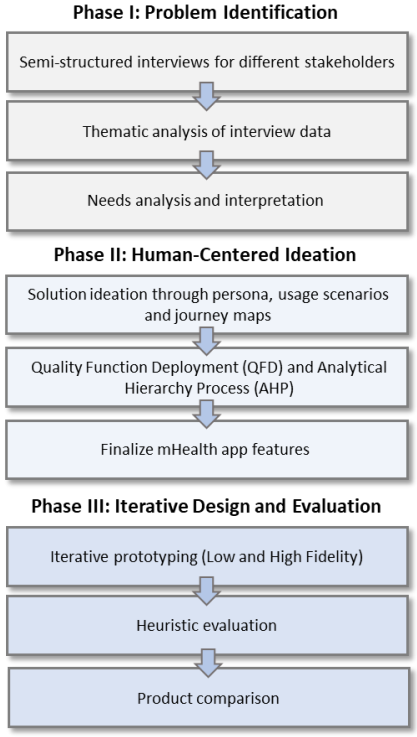

Figure 1. Research Methodology

QFD (Vaz de Oliveira et al., 2020). The AHP was used to analyze the survey data from 16 potential users to weigh the importance of each customer requirement. After that, the results were summarized in a product planning matrix or 'house of quality (HOQ)' and the app features were finalized. In the last phase, an iterative design process was employed to create multiple prototypes (low-fidelity and high-fidelity). The final prototype was evaluated by eight human factors and ergonomics experts based on the 10 usability heuristics (Nielsen 1995) and was compared to an existing application that had a high competitive score based on the QFD.

RESULTS AND DISCUSSION

Phase I. Findings from the thematic analysis showed three main emergent themes namely, (1) chronic anxiety, (2) negative experiences during seizures and (3) seizure documentation. It was revealed that most PWE/guardians experience chronic anxiety due to the uncertainty brought by unpredictable seizures, which has led many PWE to experience high discomfort and impairment in their daily functions. In addition, negative experiences associated with seizure attacks such as serious injuries and lack of proper emergency response were some of the major concerns of all of the stakeholders. Lastly, problems with regards to inaccurate and inconsistent recording of seizure episodes were also specified by most of the interviewees. Themes were analyzed and transformed into 10 specific needs (Table 1).

Phase II. Customer requirements were translated into measurable technical requirements and design aspects were identified after a thorough human-centered ideation procedure. The top design aspects that emerged were: (1) seizure diary (2) emergency mode, (3) monitoring system, and (4) seizure detection and prediction. The overall importance weights of each VOC (CR = 0.06) are summarized in Table 1.

Table 1. VOC and AHP results

Voice of Customer (VOC)	Importance Weight (%)
1. Efficient recording of seizure occurrences	9.6
2. Being able to present more accurate information to the doctor during consultations	11.3
3. User-friendly and low-cost seizure management tool	4.3
4. Notification of seizure occurrences to trusted contacts	9
5. Providing first-aid instructions to people around the patient during seizures	16
6. Calling of ambulance during critical seizures/falls/injuries	15.4
7. Monitoring of health condition/triggers and symptoms	7.7
8. Receiving reminders regarding their medications and schedules	5.7
9. Forecast of incoming seizures	12.2
10. Detection of triggers based on activities, location, sentiments and time	8.8

Phase III. The top design aspects were developed by creating design prototypes iteratively (Figure 2). Through the heuristic evaluation, a total of 82 specific usability concerns (proposed app 34.15%, existing app 65.85%) were identified from two seizure management mHealth apps. Wilcoxon Signed Ranks test revealed that the proposed app was rated significantly higher on the visibility ($Z = 0.89$, $p = 0.048$), recognition ($Z = 0.88$, $p = 0.049$) and aesthetics ($Z = 1.04$, $p < .001$) usability heuristics than the existing seizure management app.

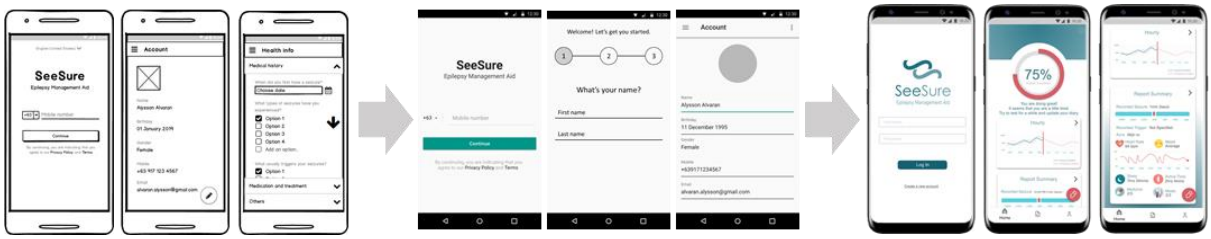

Figure 2. mHealth Design Prototypes

CONCLUSIONS

The proposed solution generated from the human-centered design process showed a good potential in addressing the current issues faced by the patients, guardians and health professionals in terms of seizure management. It promotes a better interaction system for all stakeholders involved and provides a smart and innovative solution to improve patient safety. Thus, the present study shows that human-centered techniques can be applied to design systems that would help improve the overall experience and patient safety in the healthcare domain.

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