

# Technology Improvement for Children's Health in Suburban Areas: A Self-Diagnosing Health Application as an Integration Approach for Health Practitioners

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**Abstract**— The model of 4.0 era information technology is a breakthrough that accords the convenience of an integrative, responsive, and direct activity between users and providers. Moreover, the urban-suburban contexts are now more adaptable as tools and infrastructure have been developed across regions to accelerate the advances in information technology. Hence, the use of information technology has become a promising instrument for the increase of health awareness in parents. Mobile phone technology is now accessible and it can enhance the knowledge of parents in circumstances of emergency pertaining to the health of their children. This information can also guide parents in deciding whether or not the condition they face is an emergency, and the appropriate homecare they can undertake before visiting a medical professional. This study aimed to develop a suitable m-health application for Indonesian parents using symptom-based questions and offering homecare options. A mobile phone-based application based on a symptom-based approach was developed with the help of several experienced physicians and with current medical evidence. The user interface was made simple with interactive questions for their easy access of parents. This application was then implemented on a group of parents of average socioeconomic and education background. A focus group discussion was subsequently conducted to evaluate the product and as a medium of sharing knowledge pertaining to child emergency situations and to later introduce the application. The session ended with a workshop on the use of the application. These activities accorded several insights: a positive response was obtained with regard to the clear directions for the detection of symptoms in children and the helpful homecare recommendations; however, a negative feedback was received about the use of medical terminology and about the user interface. The use of m-health for parents in developing countries is a promising instrument for the increase of parental awareness. This application should be further developed in the future to become more practicable and to enhance its ease of use by parents.

**Keywords**—*self-diagnosing application, urban health, technology for health, mobile phone application, homecare for children*

## I. INTRODUCTION

The model of 4.0 era information technology is a breakthrough that accords the convenience of an integrative, responsive, and direct interaction between users and providers. It should be used to reduce the barriers of distance between communities. As a developing country, Indonesia needs to bridge urban and suburban areas with technology due to the inequality that is present in several aspects, especially in the health and education domains. In the last decade, infrastructure had been developed to accelerate the advances in information technology in Indonesia. Thus, technology in the form of the Internet and mobile telephone are widely accessible to people at various socioeconomic levels. The extended support to suburban areas has made it a lot easier to improve the quality of nation's health and to improve several health indicators, primarily with regard to mortality (death rate caused by disease) and morbidity (sequelae in the future caused by disease) [1]. A previous study of mobile e-health in suburban areas in Africa demonstrated positive results to health quality improvements [2].

In line with other growing cities in developing countries, e-health was considered by the authors of this paper as a potential area for researches to develop technology that is useful for daily living [3]. The domain of mobile health (m-health) encompasses mobile-based communication, multimedia, and interaction in order to provide benefits to the health sector. Currently, m-health is utilized for data collection (national registry data, vital statistic data, and prospective cohort study), health promotion, care support, and emergency services, which estimated to expand

exponentially in the future [4]. Another use of m-health is to increase medication adherence and to support the cessation of chemical abuse such as smoking or alcoholism [5].

Sine Indonesia still faces major challenges in education and health, integration with technology is a priority. Education has been widely accommodated as numerous mobile-based applications now exist to support the learning of various subjects, to deliver presentations, to assist in teaching, and to provide long-distance learning programs through video calls or even interactive communication platforms such as webinars. Conversely, the health sector is not yet very influenced by technology. The primary focus of the government in the health sector is still in curative (to cure disease). The government machinery is not yet attending to focus on prevention (programs to avert the development of diseases). Further, early detection is a facet that is almost forgotten [6]. If symptoms could be discovered and perceived before the development of a disease, prompt treatment could be provided and potential disabilities could be avoided. The use of technology for the early detection of several diseases is globally emergent as it is foreseen to be a wide-ranging and cost-effective means of reducing morbidity and mortality [6]. Therefore, the authors of this paper are interested in an early detection program and have tried to utilize technology to improve the quality of health in Indonesian society, especially via mobile phones.

Another pertinent question for the implementation of this technology pertains to the identification of the target group. Based on medical theory and on the recent global epidemiology of disease, a population with high risk factors is the one that should be targeted for early detection as this population is susceptible to various diseases. Children (especially under 5 years old), geriatrics (senior citizen, aged > 65 years old), and pregnant women [7, 8] are some such vulnerable sections. Based on the basic health research data of Indonesia, the population of children is still high with 4 million infants born annually over the last 5 years. The establishment of sustainable development goals (SDGs) has made this population, along with pregnant women, the focus of a nation's health. Hence, emergency situations in child health were deemed to be the appropriate area of concentration for the present research project to implement m-health technology for the early detection of disease. It is hoped that the quality of healthcare provided for this population will exert a beneficial impact for the future generations of Indonesia.

A mobile-based application to assist the early detection of diseases and to advise homecare for child emergency situations was developed in support of the set objectives. This application can easily be accessed via mobile phones and guides parents or caregivers through emergency situations. The main goals of this application are 1) to distinguish true or false emergency cases, 2) to advise the need of immediate emergency room visit, 3) to recommend simple homecare to comfort the child, and 4) to inform when to visit the doctor in the future. This application is not aimed to replace the functions of a medical doctor. Instead, it aims to reduce the time gap during emergency situations in order to reduce fatality rates. This application is expected to calm parents or caregivers during emergency situations.

This study aimed to construct the application, to implement it in a community, and to further develop it for mass use in Indonesia. To our knowledge, this would be the

first mobile-based application in Asia to improve emergency care in children.

## II. METHODS

Several measures were taken through collaborations with medical doctors, technology experts, urban studies experts, and a community of parents to construct the application and to implement it within a community. The development of the application took a full year in 2016. The implementation of the application in a real community and the evaluation of the content were accomplished in 2017. The application was polished in 2018 to make it ready for offer to a mobile application store as soon as possible. The content and user interface of this application has also been registered for copyright in accordance with the Indonesian Ministry of Law.

### A. Constructing the Algorithm for the Application

We undertook several actions to construct a solid foundation for the development of this health application. The first step was to develop the content of the application. During this process, main symptoms commonly found in children's emergency situations were selected from the literature. After this, symptoms that could easily be observed and recognized by nonmedical personnel (parents or caregivers) were chosen by soliciting the advice of experienced pediatricians and senior medical doctors. Those chosen nine symptoms were: fever, vomiting, diarrhea, cough and dyspnea, paleness, pain, wounds and injuries, and skin rash. It is expected that these nine symptoms would encompass around 90–95% of the main health-related complaints in the population of children.

After deciding on the above symptoms, an algorithm was developed to establish diagnoses and to tender recommendations for homecare. This algorithm combined questions with specific findings from symptoms that may be detected by parents/caregivers. This algorithm comprised several questions that linked to each other for further processing into a mobile phone application. Pictures were also added to help parents understand the question or to determine findings: for example, bluish lips could be a sign of hypoxia or the color of bruising of the child's skin, and images may assist parents/caregivers in determining the symptoms presented by the child. The parents'/caregivers answers then led to a specific diagnosis known by the application. However, to comply with medical ethics, that diagnosis is not divulged by the application.

### B. True Emergency vs False Emergency Cases

The first question asked by the application is related to red flag symptoms, which are defined as indications of true emergency that requires an immediate visit to the hospital. Most parents do not know the red flag symptoms that can result in 3 to 8 dangerous conditions. When these symptoms are observed, the parent/caregiver should immediately bring their child to hospital. This process has, to date, never been executed in health applications. By providing this feature, the possibility of misdiagnosis or delayed treatment of a real emergency condition is reduced, and this aspect establishes the superiority of the application that forms the subject of the present paper.

If a case is classified as a false emergency, several subsequent questions are asked to arrive at a primary diagnosis. Several recommendations have been devised on the basis of the diagnosis to continue the algorithm. Advice may take the form of homecare tips to comfort the child, pharmacological treatment using over-the-counter (OTC) drugs, and the identification of any red flag conditions that may occur in the future and that would necessitate taking the child to a hospital emergency room. A maximum number of days of homecare are specified for each symptom. If no improvement is observed during the specified period, parents must bring their child to a doctor as the unrelieved symptom could represent a serious condition. The principle of this application is shown in Fig. 1.

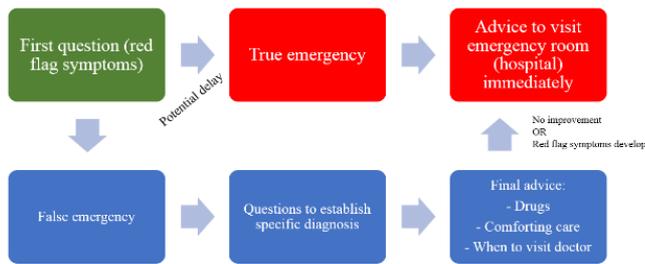


Fig. 1. The principle of this application.

The main purpose of this algorithm, besides distinguishing between different diagnoses, is also to differentiate between acute and chronic problems. It may be discerned whether a child's symptoms are acute or chronic from the number of day(s) reported by parents/caregivers. In short, this algorithm also offers an interactivity between parents/caregivers and the mobile phone application that approximates the interactions between doctors and patients in real life settings. Previously, this clinical algorithm was used in the assessment of abdominal pain in pediatric emergency rooms, but mainly on the basis of triage (a process to classify the severity of disease in the hospital emergency room) [9]. This algorithm has proved to be effective.

The user interface in this application was simplified so that parents/caregivers would be required to answer short questions, mostly in the "yes" or "no" format. However, to reduce the possibility of bias and subjectivity among parents who tended to choose the worst condition from options provided as answers, more specific questions were added. A range of 7–12 questions are required to be answered by parents/caregivers to establish a working diagnosis.

### C. Assessing Technology Applicability

A mini seminar was conducted for 50 parents in two suburban district of Depok City in West Java, Indonesia, once the application was ready. In this mini seminar, primary doctors explained the nine symptoms and a workshop was conducted on the use of the application. The simultaneous seminar and workshop increased the understanding of emergency situations among parents. After this, parents were allowed to use the mobile phone-based application in their daily life and were asked to evaluate the application in a focus group discussion two months later.

## III. RESULTS AND DISCUSSION

With time, varied evaluation and feedback were collected both from parents and from health practitioners as users of this application via in-depth interview and focus group discussions. Since the users evinced high expectations from the capabilities of this application, the program was routinely upgraded and ameliorated based on the experiences reported by users in real life situations.

### A. Self-Confidence of Parents

During the period of 8-weeks of using this mobile application, parents reported that they felt more confident in treating their child. First, they were able to understand symptoms that represent true or false emergencies. Next, they can find out what to do to make their child comfortable. Finally, they also know what kind of OTC medication they should give to their child and which drugs they should avoid.

At more in-depth interviews, parents confessed that the self-confidence they had acquired made them feel as if they were performing better as parents and that the application was like having "a private doctor" on their mobile phone. This satisfaction and sense of confidence are important aspects for parents in circumstances of emergency [10]. Sometimes, parents explored symptoms that actually did not occur to their child on the mobile application, either to fulfill their curiosity or to improve their knowledge of other symptoms. Ultimately, parents believed that the use of this application could lead to lower health costs and time spent in false emergency cases.

### B. Accessibility

This research project was conducted in a suburban area but based on observations during the mini seminar, all parents possessed mobile phones capable of supporting this application. Parents stated that the application was easy to use because they were not confused by many options and questions. The touch screen responsiveness was also adequate and no parents complained of delays or lags in the transition phases. Accessibility is important in the use of m-health technology since it correlates strongly to adherence [11]. The display of the application under discussion is shown in Fig. 2.

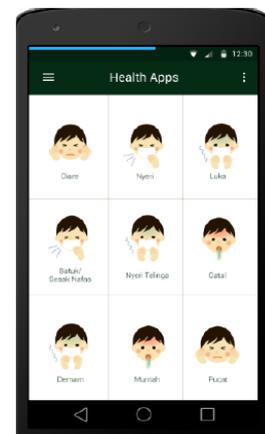


Fig. 2. English version of the application display: the symptoms are written in Indonesian.

There is a need for an adequate Internet connection while opening the application. This problem still needs to be

corrected by our team of developers. An Internet connection is required to compensate for the size of the application so that it would not take up much hard disk space in the user's mobile phone. Faced with this dilemma, a small sized application was prioritized because there is adequate Internet connectivity in most of Indonesia's suburban areas. However, connectivity could become a further consideration if to the use of the application is to be expanded to rural areas.

### C. The Use of Medical Terms

The main and the most critical evaluation of the application from users was the use of several medical words that were too difficult to understand for parents or caregivers. This obstacle is anticipated in developing a health application for the nonmedical population. This phenomenon is even more of a challenge when a health application is constructed for developing countries where the average education level is not very high and where people do not use medical terminology in their daily life. Since this application is targeted at parents/caregivers in a developing countries, several medical words were substituted with easier-to-understand words according to this significant feedback. This change did not, however, affect the main algorithm. It is concluded that a trial in a real world setting is very important before launching the application to market so that the words or terms used by an application and their suitability for the targeted population are evaluated. We also learned that this problem may also occur during traditional doctor-patients interactions: a doctor may feel that a complete explanation about the disease has been provided but parents have actually do not understand clearly what they have been told.

### D. User Interface

Some users also complained about the application's interface. This problem was predicted as the developers struggled with an impasse between a user-friendly interface and the complexity of the application. An ideally user-friendly application was not able to collect enough information from users for accurate processing and could cause the misleading working diagnosis. On the other hand, doctors always need specific details about the symptoms for a final working diagnosis to be established, and thus complexity is a must. As a first-year development, it was decided that the user interface should be prioritized instead of the complexity to increase its accessibility and applicability in everyday life. The red flag questions provided at the beginning of each symptom mitigated the risk of delayed treatment in true emergency situations as previously mentioned [1]. Therefore, the need for complex questions could be temporarily ignored during this phase of development, as no adverse medical consequences would occur.

The evaluation of the implementation of the mobile health application within a real community has resulted in the knowledge that this intervention is effective and that it may be used in suburban societies. This outcome supports the argument that it is feasible to implement mobile-integrated health care in instances of emergency and that such applications will be constructed developed in the near future [12].

## IV. CONCLUSION

The use of m-health for parents in developing countries is a promising means of increasing parental awareness of situations pertaining to child health emergencies. This application should be further developed in the future to improve its practicability and ease of use for parents. Also, similar applications may be contemplated and constructed for other high-risk populations such as pregnant woman or the elderly.

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