A Newborn Baby Care Support App and System for mHealth

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Abstract

This study was to develop a usability-engineered mhealth application for a mother with new-born baby and to evaluate its acceptance. Baby's Health Handbook and hospital consultation service records were analyzed to design the contents of app. Special interface design principles were used for enhancing usability. App data were transmitted to an Excel-based server for management. Systems were evaluated in a 800-bed medical center in Taiwan with a questionnaire designed based on the Technology Acceptance Model for Mobile Service. 64 post-partum women were invited to use and evaluate the system and services at the next day after babies were delivered. The evaluation results indicated an overall satisfying perception with an average of 3.98(SD=0.71). The subjects perceived the system meeting their expectations, needs and the majority were willing to pay for service up to $6 per month. The mhealth appears having a great potential as an important health service model.

Key Words: *New-born, Post-partum, App, mHealth, Usability*

Introduction

It takes a tremendous effort of new mothers with great support from others to take care of their newborn babies. Bowman (2005)[1] indicated that the learning needs of new mothers include issues with feeding, dealing with hicupps, detecting signs of infant illness, checking and reading bady's temperature, intepreting baby's crying signals, caring for baby's abdominal discomfort, understanding baby's growth and development, and dealing with choking and safty issues. Malon's study (2004) [2] showed that new mothers' infant care learning needs differ greatly depending on their baby's different developmental stages; on the other hand, due to the rapid changes in a baby's growth and development, it was found that there was a knowledge deficit related to new mothers' limited experience and skills in providing infant care after giving birth[3] . In addition, every mother and baby couple has unique learning needs depending on individual situations, thus, the educational materials offered have to be personalized. Furthermore, the trend of short postpartum hospital stays may leave inadequate time for new mothers to receive sufficient educational materials regarding infant care, thus, it is important for healthcare providers to ensure that the new mothers are adequately educated about important infant care topics and issues during their short obstetrical hospital stay period.

In Taiwan, the Department of Health issues every child a "Baby's Health Handbook (BHH)" for parents and healthcare providers to document the well baby check-up and growth and devlopment information. This handbook can help healthcare providers to monitor and track baby health status continously and to promote baby's general health and wellness[4]. However, the BHH provides documentation space only enough for parents and providers to record one checkup episode per month.This is indeed insufficient in many circumstances---Some parents cannot document necessary information due to its space limitation; therefore, some important health-related information cannot be captured and recorded adequately. This situation also results in preventable obstacles or barriers for healthcare providers to evaluate children's overall growth and development and to detect newborns' potential health problems[5]. Well-child policy has become a national health prority in Taiwan. Especially when the birth rate dropped to the lowest in the world recently, Taiwanese officials and parents perceive the newborn healthcare services as one of the most important issues to date. With the advancement of new technology and knowledge, a better tool should be developed to provide a more comprehensive means to monitor and document children's well-being.

Mobile health has become a very important tool to provide high quality health services[6], and its effects have also been docuemented[7]. Mobile health model uses pervasive and ubiquitous information and

communication technology, such as personal digital assistants and smartphones[8,9] to provide tools for urgent medical alerts, illness detection and disease management, to offer health status feedback and to give health consultations and suggestions[10]. However, handheld devices have certain inherent limitations, such as input mechanism and interface restraints, as well as the form factors such as screen size and resolution issues[11,12]. For a mobile application to be well received, it is imperative to take those lmitations and restraints into account when designing mobile interfaces specifically to maximize the usability and enhance user experience. Therefore, our study aimed to design a mobile infant health care and service application with a support system based on mobile usability priniciples, and then to evaluate its feasibility and acceptance.

Materials and Methods

Our study used the Palm OS-based Treo 680 smartphones and NS Basic/Palm 6.0 development tool to develop the application. The user interfaces were designed based on the 3+1 hierarchical grid principles designed for devices with small screen[13]. The focuses of the designs included but were not limited to the following functions: better thumb maneuverability, use of the click and choose menu and limited to 2- tap user input interaction. The service support system was developed using the Excel 2003 and the Visual Basic for Application.

The developed application has two primary subsystems: "Baby's Health Record System (BHRS)" and "Baby Care Consultation System (BCCS)". The BHRS was developed based on the official Taiwanese "Baby's Health Handbook", which was composed of the following seven categories: demographic data, health status, medical history, feeding, elimination, sleep and development. The BCCS was developed based on data analysis of a total of 924 telephone consultation calls regarding infant care received by the study hospital from July to December of 2009. A total of forty-two Q&A items were generated based on the top six most frequently asked categories including issues with feeding, immunizations, elimination, temperature, care of the umbilical cord and questions regarding the gastric and intestine (GI) system. Layman's terms were used rather than the professional jargons when composing those Q&A items, and all items were examined by pediatricians and other healthcare experts for validation. All Q&A items were further evaluated by randomly asking three postpartum mothers to assess their readability and understandability for the intended audience. Additional functions of this application included the ability to uploading data, trend analysis, alert messaging, and automatic updates of new information. As for the service support system, the primary features included data management and analysis abilities, baby's health status update function and the baby's periodic health reports generation.

A structured survey questionnaire was employed to assess the acceptance of the application from user's perspective. The survey questionnaire was constructed based on the "Measuring usability with the USE questionnaire" developed by Lund (2001) [14] and the "Technology acceptance model for mobile service (TAMM)" proposed by Kaasinen (2008) [15]. The survey was composed of two sections: (1) mothers' demographic data and basic information section, and (2) system evaluation section.

Mothers' demographic data and basic information section included fourteen questions concerning: age, educational level, profession, parity, birth method, planned or unplanned pregnancy, any help with baby care for the first month, whether the mother providing care for the baby, types of cellular phones used, current cellular phone model and number of cellular phones owned, most used cellular phone functions, perception for ease of use of the phone and average daily cellular phone usage. The system evaluation section was composed of forty-seven items which covered six major dimensions: evaluations of the system's usefulness (12 items), ease of use (12 items), ease of learning (4 items), trust (4 items), acceptance (4 items) and satisfaction (11 items). A five-point Likert Scale was used to measure those dimensions; the higher the point, the greater the acceptance and satisfaction of the system. Three experts were consulted to evaluate content validity of the questionnaire: the content validity index (CVI) to assess the accuracy of the instrument was 98%, the relevance measure of the tool was 96%, and the content clarity measure was 94%. The Cronbach's alpha for those six dimensions ranged from .88 to .94.

The study participants were postpartum patients from the maternity unit at a 800-bed medical center located in Taipei City. The maternity unit had fifty-three beds and the average number of births was about 100 per month. A purposive sampling method was implemented, and the inclusion criteria for the study were as follows: (1) mothers who gave birth to healthy and full-term babies (>= 37 gestational weeks) and were admitted to the maternity unit, (2) mothers who could communicate and complete the

survey using either Mandarin or Taiwanese, and (3) mothers who met the criteria and were willing to participate in the study. Data were collected after IRB approval was obtained and subjects were recruited on June and September of 2010. Statistical analyses were performed using SPSS for Windows 15.0 (SPSS, Inc., Chicago, IL) statistical packages.

Results

There are several features in this app: (1) the first screen shows the picture of new-born baby to enhance the feeling of customization (Figure 1); (2) all menu and hot keys are layouted around the sides and corners of screen with the main menu at the left side, the sub-menu at the bottom, the home screen at the left-bottom corner so mother could easily operate the app with one thumb (Figure 2); (3) the center area was designed for data entry with tapping and highlighting the data buttons with a large font (Figure 2); (4) home screen will indicate the completion of documentation for each screen under all categories with colors and mother could "jump" to the uncompleted categories by tapping the pick buttons; and (5) a Summary Report will be sent to mother through email service (Figure 4).

Figure 1. First Screen of App with Picture of New-born Baby

Figure 2. Screen Shot of "Disease History." Mother documents by tapping buttons

Figure 3. Summary Screen of Diary showing whether documentation in each category are completed (Red) or not (Pink)

Figure 4. Summary Report sent to mother after data were uploaded to center

There were 82 mothers having their babies delivered in hospital during the study period. 78 of them were qualified (the other four were foreigners and couldn't read Chinese) but only 64 agreed to participate in study.

The demographics features of these subjects are: 52% aged 31~35; 90% with colleage or university degree; 72% working as full time; 53% having their first baby; 56% in normal spontanous delivery; 69% having a baby as planned; 89% taking care of their babies on their own after delivery.

Subjects' experience with cell phones are: 100% having cell phones and 36% using smartphone; the most frequentlly used functions making a phone call (100%), sending short messages (77%) and taking pictures (47%); 61% feeling easy to operate their phones; and 69% having average monthly bill of US$7-$30.

Usability evaluaton results show that Ease of Learning was most valued (4.14), followed by Usefulness (4.07), Acceptance (4.05), Ease of Use (3.98), Satisfaction (3.86) and Trust (3.74), Table 1, Figure 5. 84% agreed with that the app could answer their questions and 81%, this mobile model could meet their needs. 94% agreed with that the app was easy to navigate among various functions and 84%, easy to use. 100% agreed with that the app was easy to learn and 90% could easily use the system without any manual. 66% trusted the security of system and didn't worry about the privacy concerns. As many as 84% of subjects were willing to pay for this service up to US$6 per month.

The statistical analysis showed that only age was associated with Trust (P=0.007), Acceptace (P=0.013), Satisfaction (P=0.022) and Overall (P=0.020). Subjects aged under 30 appeared to more agree with the values of app and system in these dimensions.

Table 1. Mothers' Perception of App in 6 Dimensions of Usability

Dimension	Average	SD	Rank
Usefulness	4.07	0.65	2
Ease of Use	3.98	0.41	4
Ease of Learning	4.14	0.43	1
Trust	3.74	0.64	6
Acceptance	4.05	0.49	3
Satisfaction	3.86	0.54	5

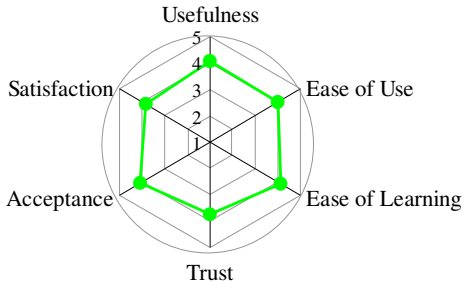

Figure 5. Radar Chart of Assessment Results

Discussions and Concluions

The new-born baby care support app was highly valued in this study. The results of acceptance and usability assessment showed subjects' positive perception of this system in all key indicators. Subjects agreed with that the app and report service meet their needs of caring their new-born baby. The majority of subjects were also willing to pay for this service up to $6 per month.

In terms of diary keeping, this app can provide mother an easy and handy tool within her mobile phone to document her baby's health status and growth patterns. She can make and keep baby's vaccination records with this app too. With regard to questions, she can first search the most frequently asked questions with answers, which were categorized similarly to Bowman's (2005) [1] findings and could be updated automatically; or she could just send a message or press the hot-line botton to connect to nurse directly. Mother can check with the growth trend of her baby and recieved a rountine summary report from service center after the data were uploaded and managed by nurses under the supervision of physicians.

The interface usability of this app was greatly and successfully enhanced using design principles proposed by Chang, et al. (2011) [13] and reduced problems frequently happened for devices with small screen[16]. The limited display area of smart phone, which was Treo 650/680 with a screen size of 4.4 cm x 4.4 cm, didn't cause any inconvenience or problem for mothers in documentation and searching answers. They very agreed with that the app was easy to use as well as to learn. We proposed a new design of the interface in this study due to the use of smartphone is differernt from PDA, such as users frequently use only one hand with thumb to interact with the device.

In our study, mothers were most satisfied with the services of Summry Report, Q&A and Reminders, such as notice of vaccination. We believe this mobile service with the app and system has a great market value if these functions could be further well designed because the majority of subjects already expressed their high intention to pay for this service.

As a matter of fact, this mobile service will not only provide mothers with better supports, it could also be used to promote the mother-baby-friendly policy. For example, within the app, the way mother feeds her baby can be well documented. It is pointed out that mother's breastfeeding at the first two weeks after delivery is critical in maintaining long-lasting breastfeeding[17]. Our service could closely and timely monitor this behavior and inform nurses to take necessary proactive prevention interventions if any interruption of breastfeeding was noticed.

We found the value of mobile service in supporting new-born baby care to mothers with well designed app and system. Mothers are willing to pay for this kind of new mobile services which will be very typical and getting popular in future mobile health. We conclude that this new type of mobile app for assisting new-born baby care, as well as other mobile applications in healthcare, deserves close attention and could be put into market for promotion. The impacts of this mobile service on mother's breast-feeding behavior, early detection of children with developmental delay and nurse's proactive caring could be further studied in the future.

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