The Development and Usability Testing of a Decision Support Mobile App for the Essential Care for Every Baby (ECEB) Program

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Abstract. mHealth is a pervasive and ubiquitous technology which has revolutionized the healthcare system for both health providers and patients (Wang et al. 2016). Each year, globally, about 15 million babies are born too soon (premature) or too small (low birthweight small for gestational age); among these 2.7 million newborns die every year due to complications from prematurity (Every New Born 2014). Common complications of prematurity like feeding problems, and hypothermia lead to high rates of morbidity and mortality among prematurely born babies each year. Delivery of evidence-based essential newborn care interventions, from birth through the first 24 h of postnatal life, has been shown to improve health and well-being, and reduce mortality, among newborns. However, due to a variety of barriers, bottlenecks, and challenges, many babies born in resource-limited settings do not receive the full complement of these lifesaving interventions. In order to address these challenges, the American Academy of Pediatrics (AAP) has developed an integrated educational and training curriculm for health care providers and family stakeholders in LMICs called Essential Care for Every Baby (ECEB). ECEB has an Action Plan, which serves as a decision support tool and job aid for health care providers. (Figure 1), by synthesizing research over a decade on helping babies survive (Essential Care for Every Baby 2018). This program teaches health care providers essential newborn care practices to keep all babies healthy from the time of birth to discharge from the facility. Yet, the nuances of monitoring, tracking and taking care of multiple babies simultaneously in neonatal wards has a big cognitive load on nurses, who must perform tasks every few minutes on each baby. The care is divided into three phases based on the time after birth: Phase 1 (0–60 min), Phase 2 (60–90 min), Phase 3 (90 min-24 h). We iteratively developed and tested the usability of the ECEB action plan, as part of the mobile Helping Babies Survive (mHBS) suite of apps, and plan to field test the app in the near future.

Keywords: ECEB · mHBS · DHIS2 · Cordova · Framework7

C. Stephanidis and M. Antona (Eds.): HCII 2019, CCIS 1088, pp. 259–263, 2019.
https://doi.org/10.1007/978-3-030-30712-7_33

1 Introduction

According to Central Intelligence Agency (CIA) infant mortality deaths are over 15 per 1,000 live births in more than 100 countries in 2017. United States itself has reported 23,000 infant deaths in 2016 as per Centers for Disease Control and Prevention (CDC) (Infant mortality 2018). One of the leading causes of death is preterm birth.

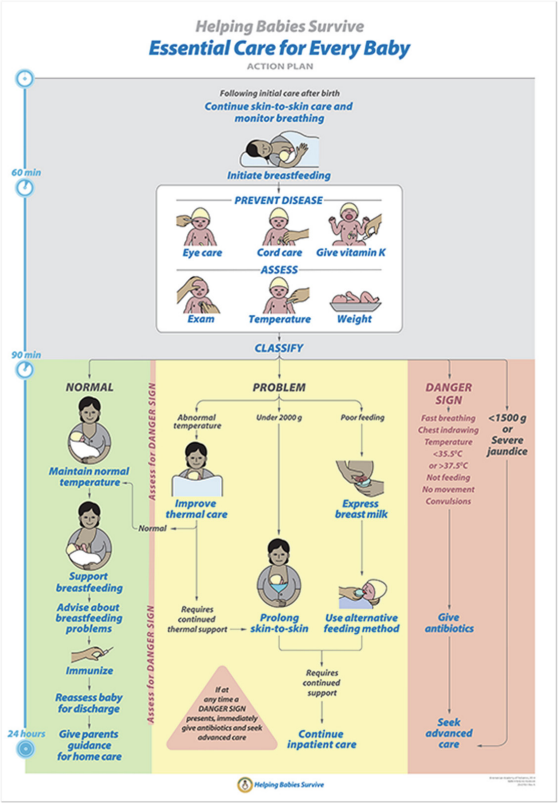

Fig. 1. Essential Care for Every Baby (ECEB) action plan

In recent years, several efforts have taken by both government and private research institutes to improve infant's health after birth often called Essential Newborn Care (ENC). Many infant deaths are reported during first day or week due to lack of this essential care. To overcome this, American Academy of pediatrics (AAP) has come up with a decision chart titled 'Essential Care for Every Baby' as part of Helping Babies Survive (HBS) program. The ECEB aims to educate all health care providers, assist mothers and families by providing knowledge and skill related to most elements of ENC. The ECEB action plan contains care that needs to be given immediately after birth to 24 h post birth based on the different baby conditions. The ECEB action plan

covers all the essential new born care like ensuring warmth, skin-to-skin care, breastfeeding, umbilical cord care, immunization, vitamin K administration and eye care. The care plan in ECEB is divided based on specific times like 90 min after birth while others follow observations like body temperature, eye care etc. (Essential Care for Every Baby, Facilitator Flip Chart).

Although the care plan is perfectly designed, the application of care is more strenuous. In environments with limited resources (health care providers), adhering to every step of the care for each baby is arduous. However, mobile health (mHealth) is growing in popularity for its ease of care and benefits which has shown to improve quality of care at a low cost. mHealth has shown to have positive outcomes in Asthma, Cardiac Rehabilitation, Congestive Heart Failure, Chronic Lung disease, Chemotherapy, Hypertension and Diabetes and other common diseases. Along with positive outcomes it has also shown to have increased adherence to treatment for patients with diabetes (Marcolino et al. 2018). Hence the aim of the study is to build a mobile application using ECEB action plan, track the care given to each new born, analyze the care and eventually identify the areas where care should be enhanced.

2 Methods

Data about each newborn is captured using mHBS powered by District Health Information Software 2 (DHIS 2). DHIS 2 is an open-source health management information system, which is used to track health programs in over 60 countries, and by over 100 global NGOs. The ECEB app makes uses of DHIS2's webservice to login health workers and display the resources that are available in their facility. We also provided a facility login, where multiple nurses might be able to share a single tablet or phone device to manage the babies delivered at a neonatology ward. The software development was started by doing a needs analysis that was based on the already developed and successful mHBS app, which is based on other programs of the AAP. A pediatrician and pediatric researcher who was involved in designing the ECEB Action Plan for AAP was interviewed to understand the workflow and the ECEB Action Plan. Based on the content analysis of the interview, we created wireframe mockups of all screens, which further guided the development of the app. We selected Cordova as the framework for app development, as the developer/designer team was comfortable and well-versed with HTML/CSS and JavaScript. In order to document the care given to the baby as per the ECEB action plan, we provide a baby details registration page, which includes baby identifier, bed number, sex, mother's name, and birth time. Once the baby is registered through the app, the healthcare provider is redirected to the different phases of the care, based on time after birth.

Each page in the mobile app consists of title (denoting phase of the baby), mothers name and running timer followed by a list of actions based on the respective phases. Phase 1 consists of checkboxes for each action completed by the nurse (shown in Fig. 2). Phase 2 consists of preventive care given as checkboxes and validated fields (numeric/option etc.) to submit physical assessment of the baby. Based on the data entered in phase 1 and phase 2, a decision support dialog box, which implements the ECEB Action Plan care processing algorithm, is displayed, from which available care

options in phase 3 is shown. These include Normal, Problem and Danger Sign care classification of the baby (shown in Fig. 3). Normal stage simply repeats the set of action items that can be completed as a list of checkboxes. Problem stage consists of three sub-phases: Abnormal temperature, under 2000 g and poor feeding. Danger Sign stage includea different reasons for the danger sign, followed by the care to be provided. Based on baby's condition, health care providers are directed to the appropriate stage and care plan.

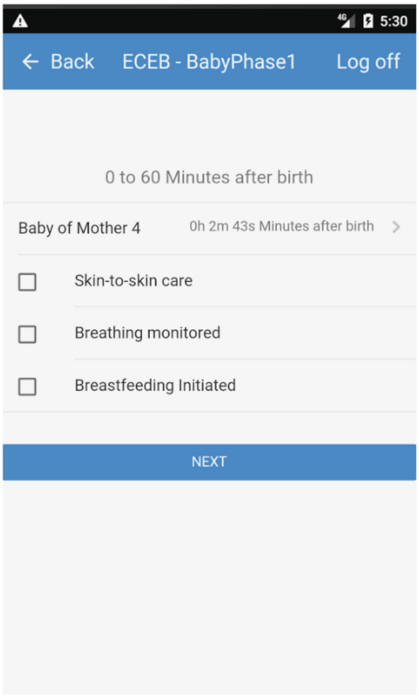

Fig. 2. Check boxes for care provided

Fig. 3. Decision support bialog box showing available care options

The data collected through each step of this app is saved to backend database immediately after navigating to the next page. Successful storage of data in the database is confirmed by green color 'tick' mark before the title on each page. Once data is entered in the database, for security and auditing purposes, it cannot be rewritten. All edits are also saved in the database.

Unique features of this mobile application are:

1. Offline Push alerts: These are notifications that are sent using the Android notification system, but still work in offline mode and do not need data services. Clicking on the alert will direct the user to the appropriate phase.
2. ECEB Action Plan Algorithm: These reduce cognitive load on nurses and reminds them when a baby needs to receive specific care intervention.

3. Data Security: Once data is sent to DHIS2, at the end of 24 h or discharge of the baby, all the details of the respective baby are deleted from the mobile application. This prevents ambiguity and makes the application user friendly.

3 Conclusion

The ECEB mobile app was developed through an iterative action-research approach, which enables a simple decision support tool for nurses and clinicians to provide appropriate and essential care for newborns. It helps reduce cognitive load of managing multiple babies and helps identify any gaps in health care professional's performance. This in turn helps to design a better and efficient care plan.

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