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Telemonitoring of High-Risk Neonates Discharged From SNCU Using a Novel Device: A Pilot Study

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Abstract

Background and Aim: CareCradle is a home-based telemonitoring device for high-risk neonates. This study examines the utility and feasibility of CareCradle for monitoring neonates discharged from a sick newborn care unit (SNCU).

Materials and Methods: Parents of high-risk neonates, < 2 months old, discharged from the SNCU of Niloufer Hospital for Women and Children (Hyderabad, Telangana, India) were given CareCradle to monitor their neonates for 2 weeks after discharge. The CareCradle prototype included a baby mat, frame and a smartphone with the CareCradle application installed. Parents were instructed to send 2.5-minute videos of their neonates 4 times a day. The nursing staff called parents twice daily and collected information regarding the neonate's condition. Trained staff reviewed and assessed the videos for danger signs as outlined in the Integrated Management of Neonatal and Childhood Illness (IMNCI) guidelines. Where necessary, clinicians recommended appropriate medical intervention.

Results: A total of 24 neonates were enrolled. Their mean gestational age was 31.2 weeks, mean birth weight was 1.46 kg, and average duration of SNCU stay was 19 days. About 47.9% of videos were sent by parents and 80% of audio accounts were completed. Clinicians could successfully assess neonates' activity

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level, abnormal chest movements, abdominal distension, and abnormal limb movements.

Conclusion: This study demonstrates that using CareCradle for home-based monitoring of high-risk neonates discharged from the SNCU is useful and feasible.

Key Words: Telemonitoring, home-based monitoring, high-risk neonate, chest movements, abdominal distension, activity level, respiratory rate, quality of care

Introduction

The neonatal mortality rate in India is one of the highest in the world, with 24 deaths per 1000 live births during the first 28 days of life.[1] The neonatal period is a vulnerable phase for neonates due to the physiologic changes that makes them susceptible to infections and other health complications.[2] About 75% of all neonatal deaths occur within the first 24 hours of birth. Many sick neonates in developing countries are found to leave health facilities early.[3] Reasons for early discharge range from shortage of beds at health facilities, parental financial constraints, and parents' perceptions that better care can be provided at home.[4] As a result, many neonates are discharged against medical advice, which results in deaths occurring at home. Up to two-thirds of neonatal deaths that occur at home could be prevented by providing access to effective and timely healthcare.[5]

CareCradle (Figure; Bempu Health, Bengaluru, Karnataka, India) is a neonatal home-based monitoring device that detects health indicators related to respiration, chest movement, crying, and activity level through video and audio accounts. Parents should upload 4 short videos (2.5-min duration) of the neonate on a specific mobile application, and trained health staff review them to assess the neonate's condition. If the nursing staff identify any abnormalities through the videos, they connect the parents to community health workers (accredited social health activists [ASHAs]) who would support them in seeking further care, if necessary. The CareCradle device was initially tested by the Bempu team.

Figure. Prototype of CareCradle

Aim

To assess the utility and feasibility of CareCradle in the early identification of signs of illnesses in neonates discharged home from the sick neonatal care unit (SNCU)

Materials and Methods

Study design

This prospective, analytical study was conducted from June 2018 to September 2018. The institutional ethics committee approval was obtained before the study's

commencement. High-risk neonates, < 2 months old, who were being discharged from the SNCU of Niloufer Hospital for Women and Children (Hyderabad, Telangana, India) were enrolled if they fit the inclusion criteria. Informed consent was obtained from parents before enrollment.

Inclusion criteria

High-risk neonates born at < 37 weeks of gestation, < 2 months old, weighing < 2 kg at birth, and who were discharged from the SNCU of Niloufer Hospital for Women and Children were included in the study. These neonates required respiratory support (ventilation, CPAP, O_2), treatment for sepsis and intensive monitoring, or close monitoring due to some morbidity. Neonates whose parents lived within 50 km from the hospital were enrolled to avoid logistic problems. A total of 28 neonates were eligible for the study. But, parents of 2 neonates did not consent for the study and 2 families lived outside the 50 km radius. Hence, 24 neonates were enrolled for the study after a staff nurse obtained written informed consent from parents.

Exclusion criteria

Neonates with syndromes, congenital birth defects, and critical congenital heart diseases were excluded.

Study procedure

The nursing staff recorded each neonate's medical history including birth weight, gestational age, weight at the time of discharge, and other necessary information. A staff nurse instructed parents about using the CareCradle device. The prototype included a baby mat made of skin-friendly material and a smartphone mounted on top of a plastic frame. The smartphone's camera captured videos of the neonate in a noncontact manner using a simple video-recording application. The families were given a charger for the smartphone. The mother was instructed to use the CareCradle application to capture a 2.5-minute video, every 4 hours, between 9 am and 9 pm for 2 weeks, at home. The phones were set up to store the videos and send them automatically to the reviewing clinicians. In the case of connectivity issues, videos were sent as soon as Internet access was restored. The nursing staff called families twice a day and collected information regarding each neonate's condition, feeding patterns, and other relevant details. Nurses on the Bempu team viewed and assessed the videos based on the Integrated Management of Neonatal and Childhood Illness (IMNCI) guidelines.

If a nurse observed any danger signs such as those related to the neonate's activity level, respiratory rate, quality of cry, and chest movements; grunting; presence of skin pustules; abdominal distension; and convulsive movement, videos were sent to the consulting physicians. The physicians viewed and assessed the videos, identified the problems, and briefed the nurses regarding the appropriate care and intervention. The nurses on the Bempu team contacted parents and advised them of appropriate home care practices and instructed them to seek skilled care where necessary. All the neonates were monitored for 2 weeks.

The Bempu field staff collected the CareCradle devices directly from the families at the end of the 2-week monitoring period. Parents were interviewed regarding any problems they faced during the study. Outcome measures included the proportion of videos that could be reviewed for clinical indicators as well as the number of audio calls completed. The parents were enquired about the reasons for not uploading the videos and not answering audio calls. The parents were also enquired if their neonate required revisit or readmission to a healthcare facility.

Results

Baseline characteristics

The mean gestational age of the enrolled neonates was 31.2 weeks, and their mean birth weight was 1.46 kg. Their average duration of stay in the SNCU was 19 days.

Utility and feasibility of CareCradle

Parents had the device for an average of 10 days. We expected parents of each neonate to send 48 videos,

but the average number of videos sent was 23 (47.9%). About 80% of audio calls (2 calls/d) were successfully completed. Video reviewers were able to assess most health indicators at a rate higher than 75%, except for respiratory rate and quality of cry (Table).

Table. Health Indicators Assessed Using CareCradle

Health Indicator	Percentage of Videos in Which This Could Be Assessed
Activity Level	100
Respiratory Rate	68
Quality of Cry	47
Chest Movement	78
Abdominal Distention	98
Any Abnormal Movement	100

Abnormal signs were identified in 4 neonates. Of these, parents of 2 neonates were successfully counseled regarding proper feeding techniques. Parents of the other 2 neonates—who were noticed to have tachypnea and decreased activity—were advised to visit a healthcare facility. Of these, 1 neonate was taken to a private practitioner and was treated for cold, while the other was admitted to our hospital and diagnosed with pneumonia. This neonate was treated at the hospital and discharged after 5 days. Another neonate who was previously treated for respiratory distress syndrome at our hospital, died during the monitoring period at home. Only 1 video was sent by this neonate's parent on the first day after discharge due to network issues, and the last audio call was answered by the mother 36 hours before the neonate's death. When the neonate was brought to the hospital again, there were no signs of life, and the neonate was declared dead on arrival; the possible cause of death was stated as aspiration pneumonia.

Discussion

Neonatal healthcare facilities have been able to deliver real-time diagnoses, without having in-house clinicians, with the help of telemedicine applications. These applications facilitate remote evaluation of digital images in retinopathy of prematurity, screening of deaf and hard-of-hearing infants, interpretation of echocardiograms, and teleconsultations.[6-11] However, only a few Internet-based tools are available to help families care for their vulnerable neonates during their initial days of life. CareCradle is the first of its kind in a developing country where high-risk neonates can be monitored after discharge from the hospital using an Internet-based mobile application.

The activity level of a high-risk neonate in a home setting is a significant indicator of health status. The physicians could assess neonates' activity level in 100% of the videos received, which is a promising factor for the CareCradle device. Additionally, abdominal distention could be assessed in 98% of the videos. Parents were educated on the appropriate time to record the videos, that is, in between feeds to avoid misinterpretation.

There are some limitations to this device. The physicians found it difficult to assess the respiratory rate and chest movements in 68% and 78% of the videos, respectively. The major reason for this was improper and insufficient lighting conditions at the homes, which affected the video clarity. In some instances, the parents were unable to correctly expose the torso of the neonate. In other cases, the neonates had hiccups while the video was recorded. The physicians were able to assess the quality of cry in only 47% of the videos, as most of the videos were recorded when the neonate was not crying.

The parents answered 80% of the audio calls. The nurses faced some challenges in this regard either because the mothers were engaged in household activities during the day or the mobile network connectivity was poor. About 52.1% of planned video uploads were not completed by parents. In 12% of the cases, videos were not uploaded because mothers were busy with household activities. About 29% of the videos were not uploaded due to network problems. Internet signals were not strong or reliable enough for instant video upload, leading to upload delay or failure. Various measures are needed to improve parents' compliance in uploading the videos. In 29% of cases, parents perceived the neonate to be uncomfortable while recording the video.

Providing a more robust onboarding and training program before commencing the monitoring period could help address these concerns and improve parents' compliance. This would include field staff training and additional education for families before the neonate's hospital discharge. In the future, the number of videos could also be reduced from 4 to 2. Providing reminders to the parents to keep the neonate's chest area visible, improving the lighting in the cradle, and using a heated mattress or specially designed clothing could mitigate the issues associated with assessing health indicators.

The high rate of audio calls completed (80%) suggests that this is a feasible way to engage with parents during the monitoring period, receive updates, and advise them regarding the neonate's activity, feeding pattern, sleep pattern, urine output, and stool pattern.

Future versions of CareCradle must include automatic vital sign monitors to obtain data on heart rate, oxygen saturation, and respiratory rate. This will enable the capturing of vital data without video reviews, bypassing the connectivity issues. This quantitative information will upload much more quickly than video files, so even if connectivity is poor, this can reduce the gaps in monitoring.

Conclusions

This pilot study shows that using CareCradle for home-based monitoring of high-risk neonates discharged from the SNCU is both useful and feasible. However, enrollment of additional neonates in a wider range of settings will be required to fully understand the clinical utility of CareCradle. With adjustments to the device such as using a wider range of SIM cards and adding vital sign monitors and providing parents with more comprehensive education, it would be possible to detect danger signs better and aid high-risk neonates in receiving appropriate and timely care. Ultimately, we look forward to reducing/preventing neonatal emergency department visits and deaths.

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