Utilizing information technology for optimizing LBW care: a systematic review

Romdzati1,3, Dessie Wanda2

ABSTRACT

The incidence of low birth weight (LBW) is still high. Based on data released by UNICEF and WHO, it is estimated that one in seven births is LBW. Due to their physical condition, LBW experienced health problems. This requires integrated management from health professions even collaboration with other scientific disciplines. Along with the times, information technology is widely used in various fields, including in health care. This study aims to identify the use of information technology to improve the quality of care for LBW. This was a systematic review. Five IT products were intended for use by LBW parents, while others were used by health workers. The use of IT in LBW has benefits, including parental self-efficacy, discharged preparedness, and length of stay (LOS). Information technology related to LBW health care has specific usage and the target user. Each has advantages and limitations or disadvantages compared to other similar IT products.

Keywords: information technology, LBW, systematic review, telemedicine.

INTRODUCTION

The high incidence of low birth weight (LBW) is still high. Based on data released by UNICEF and WHO, it is estimated that one in seven births is LBW.1,2 Due to their limited physical condition, LBW have many health problems. LBWs who have been discharged from the hospital have a readmission risk for various reasons. In the first three months, LBW can undergo rehospitalization as a result of pneumonia, jaundice, Retinopathy of Prematurity (ROP) treatment, or other health problems.3

Management of health problems in LBW is carried out since they are in the hospital and continues until they are discharged from the hospital so it requires cooperation from various parties. The geographical distance between home and health care facilities sometimes becomes an obstacle in the care of LBW. Thus, limited access to health services as a continuum of care is one of the challenges in LBW care.4,5

Along with the development of information technology, telemedicine and other forms provide answers to various existing obstacles. Telemedicine can provide solutions in the form of easy remote care.6 The benefits of using telemedicine include reducing the need for patient transfer, preventing incidents related to child safety, and reducing the length of stay.7,8 Based on this, it is necessary to conduct a literature search to identify how to utilize information technology in the treatment of LBW.

Type of information technology (IT)

Development of information technology for LBW care includes mobile health9,10, telemedicine11-14, telehealth15, mobile robot16. Based on table 1, some researchers labeled their IT products referring to common terms and put specific names such as Smart ROP17,18 NICU-2-Home smartphone applications19 and Estrellita are information technology with special designations to distinguish them from other existing products.20 Another form of information technology product was CODEC-based telemedicine carts.21

Types of information technology products related to who will use them and where they are used. Most of them are operated by health workers (66.67%), while others are intended for use by parents. Therefore, most of the users are in hospitals, especially neonatal intensive care units (NICU). Information technology can be used in screening or diagnosing2,13,17,18, monitoring and consulting21,22,11,12,13,14,15,16,21, also preparing of discharged from the hospital.9,10,19,22

Benefit of existing IT

The development of information technology is able to bring benefits to LBW, parents, and health workers, directly or indirectly. The benefits of LBW infants are directly presented in two studies.8,23 Non-contact video monitoring23 can avoid LBW from unwanted adverse effects that resulted from the procedure. Telemedicine namely e-ROP Imaging may decrease the number of infants requiring examination.18 Mothers or parents as the main caregiver of LBW infants feel many benefits for instance improving parental self-efficacy, discharge preparedness, satisfaction, and cost-effectiveness.21,17,19 Meanwhile, health workers and the hospital also receive benefits from the development of IT. Doctors, nurses, and other health workers have a positive impact, including a significant reduction in the transfer of LBW patients, and facilities in the diagnosis and management of LBW patients.3,17 Some LBW health problems such as ROP can be detected and diagnosed remotely.13,17,18 High quality of audio-video, capability to provide high-

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REVIEW

Figure 1. Study flow diagram.

resolution images, and wide field of view become important things that benefit from Smart ROP. The application of telemedicine and similar technologies also may enrich communication between the health profession and family members.

Hospitals located far from the city can access consultations with subspecialists through telemedicine facilities. Another benefit of information technology utilization is decreasing in the length of stay or LOS.

**Limitation or Disadvantages of IT products**

Although information technology products have been designed as perfectly as possible, some have limitations. Internet connectivity, camera focus, relatively large size, technical imaging difficulty, and image acquisition were identified as limitation or problem of some existing information technology products.

Mobile health that utilizes the SMS feature with limited number of characters also has limitations in delivering written messages to LBW parents.

Our review found that information technology was already used in caring for LBW. There are several types of naming according to the function and purpose of each of these information technology products. The general term most frequently encountered in this review is telemedicine. Telemedicine in neonatology has experienced evolution gradually. It covers fetal care, newborn resuscitation, remote rounding, teleconsultation, virtual visitation for parents, retinopathy of prematurity evaluation, and parental support following infant discharge.

Various fields of health also have used many types of information technology. In the nursing field, telenursing has been identified to facilitate in giving health education for the patient. In the pharmacy field, there is telepharmacy which has benefits for travel time and expense, reduction in antimicrobial medication, and others. Meanwhile, other types of information technology products namely smartphone applications were also found in physical activity promotion in primary care.

Information technology products can be used and operated by anyone following their intended purposes. In terms of LBW care, there are two interested parties, namely parents and health workers. If the technology is intended for parents, the features listed will adapt to the needs of parents to care for the babies. This review discovered five devices designed for parents. As a representation of parents’ needs, researchers captured their aspirations so that the development of tools can bridge these needs.

Through focus group discussion (FGD), Lakshmanan et al identified eight domain to build their mobile health. These are content formats, the timing of events, path planning, provision of information, accessing support, engagement with the provider, barriers to caring after discharge, parenting role, and confidence. Other researchers also explained the process to gain content in their mobile health.

Proper information in the mobile health features including content to facilitate discharge preparedness can help a mother to understand their role in taking care of their LBW baby. Literature explained that there is a relationship between discharge preparedness and mother self-efficacy. This statement is in line with the research finding. Moreover, Anand et al conducted a research project, the result showed that early discharge planning in preterm LBW babies positively contributed to the length of stay (LOS).

Many advantages arise from utilizing information technology, however, not all articles reveal this. Of the many articles that discuss, benefits can come directly or indirectly to LBW babies. During hospitalization, LBW infants undergo several procedures starting from diagnostic tests until treatment management. Safe medical procedures for older and bigger infants may create a hazard for LBW since their immature organs. Non-contact video monitoring and non-contact diagnostic tests such as e-ROP imaging and Smart
ROP provide positive outcomes related to this problem. Non-contact instruments may avoid LBW from the risk of skin damage and infection. Indirect benefits can be obtained through parents who care for them or from health workers. Telemedicine could enrich communication with family. Proper care from parents can keep LBW’s health condition stable so it may minimize LBW experiencing serious health problems.

Health workers, through their ability to operate information technology products, bring benefits to the LBW baby. The ease of use of information technology products supports the accuracy of procedures for actions taken by health workers. For example, the Wired coder can be controlled by a remote neonatologist during neonatal resuscitation telemedicine (NRTP) so that he or she can view it clearly, and subsequently give suggestions or instruction to the local health professional team related to LBW condition and the intervention. Video and audio quality are complementary to other functions.

The utilization of information technology products allows for a more equitable range of health services for LBWs who are treated in distant hospitals. ROP as a premature baby’s problem can be diagnosed by an ophthalmologist remotely. E-ROP and Smart ROP facilitate ophthalmologists to contribute to dealing with eye problems among LBW even though they are far apart. This is in line with the finding that telemedicine provides healthcare from distance and without physical interactions with patients.

In the process of using it, telehealth and similar technologies still have weaknesses and limitations. The internet as an important component can be a source of obstacles, especially when connection instability occurs. Through filling out a survey on the use of mobile robots, health workers said that sometimes technical problems arise related to internet connections, this is supported by research on the association of broadband internet and telemedicine utilization. Other barriers that become opportunities for improvement include technical imaging difficulty, camera focus, image acquisition, and the size of equipment. To overcome the first three problems, technicians or health workers may practice intensively and there is a long-term effort to make a more suitable design to operate easier. The size of equipment becomes a problem when the room to take care of the baby is relatively narrow. The movement to shift the tool becomes less flexible. This requires the health workers involved to be able to maximize functions with these limitations, as well as a challenge to come up with better device designs.

CONCLUSIONS

Information technology provides benefits for LBW care, however, it is necessary to continue to improve its quality. Researchers need to explore further the technology that has been applied so that they can reveal gaps for improvement. Good quality care for LBW can improve health status and reduce the risk of more severe health problems. As the result, mortality and morbidity of LBW also decreased.

DISCLOSURES

Funding
None.

Conflict of Interest
The authors declare that there is no conflict of interest.

Ethic Approval
Not applicable.

Author Contribution
All authors contributed to this study’s conception and design, data analysis and interpretation, until reporting the result for publication.

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REFERENCES


Table 1. Characteristics of articles included in the final analysis.

<table>
<thead>
<tr>
<th>First author name and year</th>
<th>Design</th>
<th>Sample</th>
<th>Type of technology</th>
<th>Short description</th>
<th>User</th>
<th>Setting</th>
<th>Benefit and Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lakshmanan (2022)</td>
<td>Qualitative study</td>
<td>22 participants (11 caregivers, 11 providers)</td>
<td>Mobile health</td>
<td>The study was conducted to elucidate caregiver and provider perspectives on mobile health application design to facilitate transition from NICU to home.</td>
<td>Parent</td>
<td>Transition from NICU to home</td>
<td>N/A</td>
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<td>Garfield (2016)</td>
<td>RCT</td>
<td>90 parents of VLBW (n=44 for usual care, n=46 for usual care plus NICU-2-Home)</td>
<td>Smartphone application (NICU-2-Home)</td>
<td>The study compared self efficacy, preparedness for discharged and length of stay (LOS) between two groups</td>
<td>Parent</td>
<td>Transition from NICU to home</td>
<td>Benefit: NICU-2-Home application can improve parenting self-efficacy, discharge preparedness, and LOS Limitation: N/A</td>
</tr>
<tr>
<td>Nourani (2019)</td>
<td>Quantitative study</td>
<td>First phase: 60 participants (20 neonatal physicians, 20 NICU nurses, 20 mothers of premature baby) Second phase: 20 mothers</td>
<td>Smartphone</td>
<td>The study developed a smartphone application to educate the mothers of premature infant</td>
<td>Mother</td>
<td>Hospital</td>
<td>N/A</td>
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<td>Tang (2012)</td>
<td>Qualitative study</td>
<td>29 participants (17 mothers, 1 aunt as caregiver, 11 health professionals)</td>
<td>Mobile health: Estrellita</td>
<td>The study is for designing an effective mobile health tool to better understand data capture and access needs for caregivers of preterm infants</td>
<td>Parents</td>
<td>Home care</td>
<td>N/A</td>
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<td>Makkar (2019)</td>
<td>Prospective, non inferiority study</td>
<td>155 preterm babies: 85 at CCMH (Commanche County Memorial Hospital) and 70 at Oklahoma University Medical Center (OUMC)</td>
<td>Hybrid Telemedicine</td>
<td>The study evaluated the safety and efficacy of premature infant treatment managed by hybrid telemedicine versus conventional care.</td>
<td>Health worker</td>
<td>NICU Worker</td>
<td>Benefit: 1. Safe and cost-effective way to extend intensive care to late premature neonates 2. Parental satisfaction was particularly high due to reductions in transportation difficulties 3. Length of stay (LOS) was shorter than conventional care Limitation: N/A</td>
</tr>
<tr>
<td>Albritton (2018)</td>
<td>Multiple baseline design</td>
<td>44,643 births</td>
<td>Telehealth</td>
<td>The study evaluated the use of telehealth neonatology consult services for urgent and emergency newborn condition</td>
<td>Health worker</td>
<td>Hospital</td>
<td>Benefit: A significant reduction in transfer Limitation: N/A</td>
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<td>Beck (2017)</td>
<td>Retrospective study</td>
<td>Pre intervention: 99 consultation, Post intervention: 73 consultation</td>
<td>Wired coder/decoder (CODEC)-based telemedicine carts</td>
<td>This study compared the effectiveness of two telemedicine technologies for providing newborn resuscitation telemedicine consults between a wired telemedicine cart and wireless tablet</td>
<td>Health worker</td>
<td>Hospital</td>
<td>Benefit: 1. Wired telemedicine carts improved reliability, user satisfaction 2. Reliable connection, camera controlled by remote neonatologist, quality of video and audio Limitation: Cart size and limited mobility</td>
</tr>
<tr>
<td>Garingo (2015)</td>
<td>Prospective study</td>
<td>40 babies (birth weight: 1,517.5 to 2,457.5 gram)</td>
<td>Mobile robot</td>
<td>This study investigated the feasibility of ‘tele-rounding’ in neonatal intensive care unit by comparing on-site NICU team lead by an on-site neonatologist and on-site NICU team lead by an off-site neonatologist using a remote-controlled robot</td>
<td>Health worker</td>
<td>NICU</td>
<td>Benefit: Telemedicine may be a feasible alternative to perform patient rounds especially for NICU that do not have the availability of 24/7 on-site coverage Limitation: 1. Occasional problem with internet connectivity 2. Could be detrimental to the clinician-parent/staff relationship since decrease bedside presence of neonatologists</td>
</tr>
<tr>
<td>McCauley (2018)</td>
<td>Retrospective study</td>
<td>Pre intervention: 11 MCHS local provider, 15 teleneonatologist, Post intervention: 55 local provider, 74 teleneonatologist</td>
<td>Telemedicine</td>
<td>This study compared the quality and reliability of two telemedicine technologies (wired telemedicine cart and Intouch Health Lite V2 or ITH Lite V2) in conducting the newborn resuscitation telemedicine programs (NRTP)</td>
<td>Health worker</td>
<td>Hospital</td>
<td>Benefit: 1. Accessible for a subspecialist 2. Improved in allocation of resources 3. Enriched communication with family member Limitation: 1. The video image became pixillated, delayed, or froze during the maneuver 2. Occasional difficulty with camera focus, particularly with ITH Lite V2</td>
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<td>Weaver (2012)</td>
<td>Retrospective study</td>
<td>137 preterm infants</td>
<td>Telemedicine</td>
<td>This study used The Stanford University Network for Diagnosis of Retinopathy of Prematurity (SUNDROP) telemedicine screening initiative photography protocol. Retinal images were posted on a secure, password-controlled server for evaluation by one of two pediatric ophthalmologists.</td>
<td>Health worker</td>
<td>NICU</td>
<td>Benefit: It can detect ROP that ultimately required laser treatment. Limitation: Technical imaging difficulties and artifactually induced posterior pole vascular changes.</td>
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<tr>
<td>Gurwin (2017)</td>
<td>Multicenter prospective study and multicenter retrospective cohort study</td>
<td>242 preterm infants</td>
<td>Telemedicine (e-ROP)</td>
<td>E-ROPIMAGING became the third approach of four approaches in a tiered approach to retinopathy of prematurity (TARP).</td>
<td>Health worker</td>
<td>Hospital</td>
<td>Benefit: It can decrease the number of infants requiring examination. Limitation: Image acquisition requires skilled imagers to maximize image quality for trained reader grading.</td>
</tr>
<tr>
<td>Villaroel (2019)</td>
<td>Clinical study</td>
<td>30 preterm infants</td>
<td>Non-contact video monitoring</td>
<td>This non-contact video monitoring can estimate the heart rate and respiratory rate of preterm infant with accuracy estimation at least 90% of time.</td>
<td>Health worker</td>
<td>NICU</td>
<td>Benefit: Prevent preterm skin damage that resulted from attachment of conventional vital-sign monitoring.</td>
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<td>George (2021)</td>
<td>Mixed method design</td>
<td>Phase 1: 9 participants (mother) Phase 2: stakeholder panel (n=10 expert of multi-disciplinary team) and user-group (n=18 mothers of preterm infants)</td>
<td>Mobile Health</td>
<td>This study was held to design a mobile health to cope with needs of mothers in the transition period of preterm infant’s discharge from hospital.</td>
<td>Mother</td>
<td>Hospital to home</td>
<td>Benefit: The messages provided by mobile health came from stakeholder and user group panel. Limitation: The SMS message will be limited of 160 characters.</td>
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<td>Asturias (2021)</td>
<td>Quantitative, Retrospective</td>
<td>418 preterm infant</td>
<td>Telemedicine</td>
<td>Images and patient information (risk factors and medical history) were uploaded onto an online database, then will be graded by one of three ophthalmologists.</td>
<td>Health worker</td>
<td>Hospital</td>
<td>N/A</td>
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