Contribution of information technology (IT) system in overcoming neonatal jaundice: a systematic literature review

D Anggraini², M N Widyawati³, S Suryono³

¹Master of Applied Science in Midwifery, Poltekkes Kemenkes Semarang, Indonesia.
²Postgraduate Applied Science Midwifery Program, Poltekkes Kemenkes Semarang, Indonesia.
³Departement of Physics, Faculty of Science and Mathematics, Universitas Diponegoro, Semarang, Indonesia.

Corresponding Author: suryono@fisika.undip.ac.id

Abstract. Information technology systems can improve efficiency, quality of service, security and improve the quality of diagnosis, especially in the incidence of neonatal jaundice, because the incidence of jaundice that is not monitored can cause increasingly severe problems so that it can cause kernicterus and can also cause death in neonatal. This paper is focused on analyzing the contribution of information technology systems to health problems especially neonatal jaundice. The study design uses a systematic literature review with international journals in electronic databases. Journal criteria used the Randomized Controlled Trial (RCT) technique from 2011-2019. This systematic literature review concludes that information technology systems have a role in health care, wherefrom several technologies have proven to be able to detect, diagnose, treatment and education that is easy, fast, effective and can be used whenever needed in overcoming the problem of neonatal jaundice. However, the use of information technology systems has not been comprehensive so that it needs development especially in areas with limited access.

1. Introduction

Neonatal mortality rates in the health care system in each country are one of the main indicators, efforts that can improve these indicators by identifying the causes of neonatal mortality and related factors, where the most common causes of neonatal death is caused by respiratory distress syndrome, sepsis, prematurity (gestational age under 37 weeks) and low birth weight (<2,500 grams) [1]. Babies with Low Birth Weight (LBW) are significantly higher associated with jaundice problems until a very severe occurrence, this causes a difference when compared to newborns with normal birth weight [2].

Jaundice occurs because fetal hemoglobin is metabolized by an immature liver which results from the accumulation of bilirubin [3]. The problem of Jaundice is characterized by a yellow discoloration of the sclera and newborn skin because the baby's blood contains excess bilirubin resulting in the occurrence of pigment in red blood cells, this mostly appears on the second and fourth day which is caused by an increase in bilirubin in the blood [4]. Neonatal jaundice must be evaluated to prevent dangerous side effects such as making a diagnosis and handling on time is indispensable, so that the problem of jaundice can be used as a most basic policy in providing services to health care [5].

Health care providers around the world realize that the causes of morbidity and mortality are due to severe neonatal jaundice, Untreated jaundice can cause kernicterus which is a major cause of
neurological disability (choreoathetosis cerebral palsy, language difficulty and deafness) or can even lead in neonatal death so that appropriate technology is very needed to see the severity of jaundice and include tools that can promote such as serum bilirubin measurement that can be included as a follow up in routine maintenance and simpler transcutaneous bilirubin measurement [6].

Health information technology can provide a variety of benefits by increasing productivity, reducing costs, increasing access to information, increasing patient safety, more effective communication between providers and providing better care [7]. Information and communication technology provides opportunities for extraordinary innovations in health care, such as therapeutic coordination systems and technology-based treatments that include cellular, web, computing, sensing and bioinformatics technologies that offer entirely new health service models, both inside and outside the formal care system and offer opportunities for a large impact on public health [8].

Information technology in improving the quality of services in hospitals plays a very important role in the field of communication, availability, and accuracy which overall seems weak so that by applying information technology with the principles of effectiveness and efficiency can make information technology in health services especially hospitals that can focus on payment transactions, patient registration, taking medical records, besides that it can also provide quality in services such as diagnosis, pharmacy, nursing and support for patients that can affect patient satisfaction [9].

Incomplete medical record data on health services can cause delays in diagnosing and providing therapy that can worsen the patient's health condition, so that a web-based information system with artificial intelligence can be used as a solution in solving these problems, rules-based artificial intelligence that is processed using algorithms can produce appropriate diagnoses and recommendations, so the developed system is expected to improve the quality of better data completion and also access to users, where the developed information system is able to solve data problem that is not comprehensive and also the effectiveness in providing a treatment [10].

Information technology tools that have been used are Electronic Health Records (EHR) is a health record that can collect, create and store health records electronically, the core components of electronic health records include administrative functions, computerized doctor order entry, pharmaceutical systems, radiology systems, laboratory systems and clinical documentation, so that it can improve the quality of security, improve the efficiency of health care and lower health care costs to consumers, besides the importance of hardware implementation, software and information technology networks for the success of electronic health records [11]. Telehealth can be used as a support for remote services such as monitoring, education and patient care that must be integrated into hospitals and outpatient practices to achieve a full potential that can be done electronically [12]. E-prescribing is used to reduce errors in treatment and be able to improve the more efficient prescribing process by exchanging electronic data on medical practice and pharmacy [13].

This paper discusses the contribution of information technology systems in overcoming the problem of neonatal jaundice, there are several studies that say that information technology systems have an influence in the field of health. Therefore, the authors intend to carry out a systematic literature review and aim to analyze the contribution of information technology systems in overcoming the problem of neonatal jaundice.

2. Method
Systematic literature review as a method to understand the information technology systems in the health field and as a means to provide answers to questions. This systematic literature review is determined from research topics on more specific questions among others:

2.1. Writing steps
The steps for writing a systematic literature review paper using the Systems Development Life Cycle (SDLC) are shown in Figure 1. These steps include:

a. Analysis. The analysis is carried out according to user needs.

b. Design. This stage makes design by collecting all existing data and information.
3. Result and discussion
This systematic literature review is carried out by finding relevant references to the contribution of information technology systems in overcoming the problem of neonatal jaundice, obtained as many as 10 articles which show that information technology can detect, diagnose, treat and educate the problem of jaundice, as follows:
3.1. Detecting neonatal jaundice

Detection of bilirubin can be done in newborns to see the severity of the incidence of jaundice by using non-invasive devices such as bilichek and bill capture, where measurement of total bilirubin levels get high correlation results using bilichek ($r^2 = 0.88$) and using bill capture ($r^2 = 0.73$), in addition, there are also differences in the sensitivity value of 92.0% and specificity of 75.6% using bill capture with a sensitivity value of 88.0% and specificity of 76.0% using bilichek, so bill capture with optical imaging is a non-invasive device that can determine the level of jaundice occurrence economically [15].

Smartphones can be used as a simple screening tool to assess hyperbilirubin in neonates equipped with a consistent light source in the form of a dermatoscopy consisting of blue intensity with a discrimination limit of 190 revealing a sensitivity value of 90.9% and a specificity of 60% with a total plasma bilirubin 205 µmol/L while the intensity of the green color with a discrimination limit of 212 has a sensitivity of 100% to identify newborns with a total plasma bilirubin >205 µmol/L and a specificity of 62.5% [16]. Electrochemical sensors can be used to detect bilirubin by showing fast response results with satisfying stability and reproducibility limits, so the development in detecting using RGO nanosheets can functionally expand the application area which is selective in detecting biomolecules such as urine and blood [17].

Monitoring jaundice in newborns by using preprocessing combination methods with an algorithms as a simple color detector can newborn skin by providing early support and more effective in knowing the problem of jaundice, where the development of the jaundice detection system involves three tasks namely skin detection, the stage of preprocessing and feature ecstasy that can distinguish normal baby’s skin color and jaundice baby’s skin color by using a validation test based on the K-Nearest Neighbor (K–NN) classification [18].

Detection of bilirubin using polyethylenimine cationic polymer which has been modified from human serum to be induced in aggregation at quantum albumin points using a spectral imaging microscope on a single molecule that is easy to distinguish and correlates with the concentration of bilirubin, this method can selectively detect bilirubin with the lowest limit of 0.6 nM and successfully applied to the detection of bilirubin in all blood samples with satisfactory results [19]. Modified electrodes as an application are used to measure the concentration of bilirubin in blood samples that are very sensitive to the electrochemical oxidation of bilirubin with a correlation coefficient of 0.9960 and the concentration of bilirubin has increased linearly from 1 to 5,000 µM, while the Michaelis constant is 44±0.4 µM, this electrochemical method has a low bilirubin detection limit on electrode modification that is equal to 1.4 µM [20].

3.2. Diagnose neonatal jaundice

Neonatal jaundice can be diagnosed using the application of data mining which contributes to the reduction of jaundice cases and the risk of hyperbilirubin development in newborns which can put them in danger in the first 24 hours of life, measurement of hyperbilirubinemia using an algorithm that is simple logistic, multilayer perceptron and naive Bayes obtained an accuracy rate of 89%, data mining as a new technology can contribute to improve the diagnosis of jaundice and support medical decisions [21].

3.3. Treatment of neonatal jaundice

Treatment of jaundice can be carried out using specially designed phototherapy by comparing three LED phototherapy machines namely two phototherapy machines with one side (lullaby and PTV 3000) and one phototherapy machine with two sides (firefly), the use of two-sided phototherapy can reduce treatment time, increase speed reduction of total bilirubin levels, and reduced length of stay at NCU [22].

Filtered Sunlight Phototherapy (FS-PT) is also effective in treating newborn babies who experience jaundice problems in areas with limited resources, where filtering is done in two canopies by transmitting about 79% of blue light in cloudy weather and the use of film canopy in weather bright can
transmit blue light around 33% (wavelength range: 400 to 520 nm) by maintaining radiation levels in blue light above 8 μW/cm²/nm so that exchange transfusion events can be avoided [23].

3.4. Education
Educational interventions which is provided to providers in medical care can save costs, especially in overcoming the problem of improving the quality of the newborn’s room, where clinical guidelines as a tool that can facilitate compliance and use of interventions against medical providers that can significantly improve the quality of care, can reduce jaundice as much as 50% in the first week of life and can improve adherence to primary care [24].

4. Conclusion
The paper from the systematic literature review of this concludes that information technology systems can overcome the problems of jaundice by detecting, diagnosing, treating and educating. The information technology systems used are cheap and accurate in screening jaundice with sensitivity and specificity values of 100% and 62.5%. Treatment of jaundice that can be carried out using information technology systems such as phototherapy and filtered sunlight phototherapy. So, the recommendation for further research is to develop more about information technology systems, especially in regions with limited resources.

Reference
[1] Babaei H, Dehghan M, Pirkashani L M 2018 International Journal of Pediatrics 6 7641–7649
[2] Hossain M, Begum M, Ahmed S, et al. 2015 J. of Enam Medical College 5 104–109
[3] Brits H, Adendorff J, Huisamen D, et al. 2018 African Journal of Primary Health Care & Family Medicine 10 1–6
[4] Arulmozhi A, Ezhillarasi M 2014 J. of Theoretical and Applied Information Technology 65 881–889
[5] Tavakolizadeh R, Izadi A, Seirafi G, et al. 2018 European J. of Translational Myology 28 257–264
[6] Slusher T M, Zipursky A, Bhatuni V K 2011 Seminar in Perinatology 35 185–191
[7] Naylor Karline, Treurnicht, Kudlow P, Li F, et al. 2011 the University of Western Ontario Medical Journal 80 17–19
[8] Marsch Lisa A, and Gustafson David H 2013 J. of Dual Diagnosis 9 1–4
[9] Itumalla R 2012 International Journal of Innovation, Management and Technology 3 433–436
[10] Mujahidah S, Suryono S, Widyawati M N 2019 Journal of Physics: Conference Series 1179, 1–6
[11] Seymour T, Frantsvog D, Graeber T 2012 American Journal of Health Sciences 3 201–210
[12] Schwamm L H 2014 Health Affairs 33 200–206
[13] Grossman J M, Cross D A, Boukus E R, et al. 2012 Journal of the American Medical Informatics Association 19 353–359
[14] Devi T R 2012 International Journal of Scientific & Engineering Research 3 1–5
[15] Rizvi M R, Alaska F M, Albaradie R S, et al. 2019 Oman Medical Journal 34 26–33
[16] Munkholm S B, Krøgholt T, Ebbesen F, et al. 2018 PLoS One 13 1–11
[17] Zheng Z, Feng Q, Zhu M, et al. 2019 Analytica Chimica Acta 1072 46–53.
[18] Mansor M N, Hariraran M, Basah S N, et al. 2013 Neurocomputing 120 258–261
[19] Zhao W, Zong C, Lei T, et al. 2018 Sensors and Actuators: Chemical 275 95–100
[20] Kannan P, Chen H, Lee V T W, et al. 2011 Talanta 86 400–407
[21] Ferreira D, Oliveira A, Freitas A 2012 BMC Medical Informatics and Decision Making 12: 1–6
[22] Arnolda G, Chien T D, Hayen A, et al. 2018 Plos One 13 1–12
[23] Slusher T M, Olusanya B O, Vreman H J, et al. 2013 Trials 14: 1–10
[24] Waldrop J B, Anderson C K, Brandon D H 2013 Journal of Pediatric Health Care 27 41–50