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Automated Phototherapy Model for Neonatal Using Transcutaneous Bilirubinometer

[*1]A. Mohammed Azarudeen, [2]Ms. S. Maheshwari, [3]S. Nandhini, [4]T. Prasanth, [5]S. Shebin Stephen

*[*1]Bachelor of Biomedical Engineering, Department of Biomedical Engineering, Velalar College of Engineering and Technology (Autonomous), (Affiliated to Anna University), Thindal, Erode-638012*
[2]Associate Professor, Department of Biomedical Engineering, Velalar College of Engineering and Technology (Autonomous), (Affiliated to Anna University), Thindal, Erode-638012
3Bachelor of Biomedical Engineering, Department of Biomedical Engineering, Velalar College of Engineering and Technology (Autonomous), (Affiliated to Anna University), Thindal, Erode-638012
[4]Bachelor of Biomedical Engineering, Department of Biomedical Engineering, Velalar College of Engineering and Technology (Autonomous), (Affiliated to Anna University), Thindal, Erode-638012
[5]Bachelor of Biomedical Engineering, Department of Biomedical Engineering, Velalar College of Engineering and Technology (Autonomous), (Affiliated to Anna University), Thindal, Erode-638012

Abstract
Hyperbilirubinemia is a clinical condition which is common and frequent problem in neonates which is clearly visible. Management of this risk requires phototherapy which is a non-invasive therapy. Even though the treatment is noninvasive, the assessment of bilirubin level in newborn requires venous or pricking to get blood samples. Transcutaneous bilurubinometer is an east, convenient and timesaving and comfortable procedure for the newborns. Jaundiced newborn require more attention and close monitoring of their vitals, bilirubin level and hydration level should be monitored. So we designed a treatment method which will be a safest treatment. The device made in this study, the intensity of the light will be automatically adjusted. The phototherapy model is completed automated, it will turn on and off according to the bilirubin and temperature levels.
Keywords: *Hyperbilirubinemia, Non-invasive, Transcutaneous billirubinometer, Jaundice, Phototherapy.*

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I. INTRODUCTION

Hyperbilirubinea is a clinical condition which is common and frequent problem in neonates which is clearly visible. Management of this risk requires phototherapy which is a non-invasive therapy [1]. Duration of therapy will be prescribed according to the bilirubin level. Even though the treatment is noninvasive, the assessment of bilirubin level in newborn requires venous or pricking to get blood samples. For a days old baby, the detecting and follow up is a painful and invasive procedure [2]. This makes the caretaker and medical professional uncomfortable. Transcutaneous bilurubinometer is an east, convenient and timesaving and comfortable procedure for the newborns [2] Considerable studies shows a good correlation between TSB and TcB. TcB is very much required which decreases the need of TSB [3] Jaundiced newborn require more attention and close monitoring of their vitals , bilirubin level and hydration level should be monitored. Phototherapy changes according to the serum bilirubin level of the newborn. Number of LEDs will be changed according to the level. This requires man power and separate serum bilirubin level for each and every time. The LEDs can be automatically switched on and off corresponding to the TcB level. The Number of LED which need to be switched on can be automated according to the bilirubin level [4]. The neonates will experience poor feeding due to increased bilirubin level. So the intake and outtake level of the baby and temperature level should be regularly monitored.

II. MATERIALS AND PROPOSED METHOD

2.1 Material Used

In this study, it stand in need for multiple electronic devices and innumerable data to make the device automatic. It consists of two different devices which include monitoring devices and output devices.

2.2 Monitoring device

i. It has a transcutaneous bilurubinometer model which measures the baby bilirubin level.
ii. The model displays the temperature of the baby and it controls the buzzer and led.

iii. The billurubin data which collected can be given as an input to IC (AT89C51).

2.3 Output devices

i. There will be three LEDs which will be controlled by bilurubinometer and thermistor.
ii. IC (AT89C51) will also handle the LEDs.
iii. Buzzer will be connected to the thermistor, it will guide the buzzer to alarm if the temperature is high. The buzzer will also alarm every two hours to feed the baby to reduce dehydration.

2.4 Proposed method

Bilirubin is a yellow colored substance the body creates during the process of replacing Red Blood Cells. The Normal bilirubin range of neonate is 13-15 mg/dl. The neonate whose bilirubin range is above the normal range are suggested for phototherapy treatment. The term phototherapy means a special light that helps to breakdown the bilirubin in the baby's skin, so it can be removed from the baby body. This lower the bilirubin level in a baby's blood. At the time of the treatment, babies are placed under the light source with the bilirubin sensor. This sensor is non-invasive and is placed on the hand of babies. This sensor helps to detect the bilirubin range in the baby's body and it controls the light source passed on the neonate/ baby's body. The intensity of the light source will be directly proportional to the neonate's bilirubin level and it is shown in table 1.

Table 1: Range of Bilirubin

Bilirubin Range	***No. of LED Glow***
15-20 mg/dl	Single
20-28 mg/dl	Double
Above 30 mg/dl	Triple

When the baby is under the phototherapy treatment, it's temperature is slightly above the normal range which is considered as normal temperature of the baby at that time. If a baby is getting dehydrated during treatment time, the temperature is very high and high bilirubin level also leads to high temperature. It cause fever. If this happens, the comorbidity level of the neonate will be high. This increasing temperature can be observed by a temperature sensor and the buzzer will be turned on. The effect of light source is automatically cut-off. The neonate can be taken out and hydrated. The treatment can be continues once the baby's temperature attain normal. It is necessary to feed a baby undergoing phototherapy once in every 2 hours. If not hydrated in such cases, it faces a problems like dehydration, Skin rash etc., to overcome that we include a buzzer which start its alarm for every 2 hours for feeding. If the baby have severe dehydration, IV fluids can be started over. If the Bilirubin level and temperature come back to standard, the phototherapy treatment will be automatically turned off.

2.5 Block Diagram

The block diagram of the proposed method consists of power supply, Thermistor,Transcutaneous Bilirubinometer, AT89C51 microcontroller, Buzzer and LED's. The block diagram of the proposed method is shown in fig. 3.1.

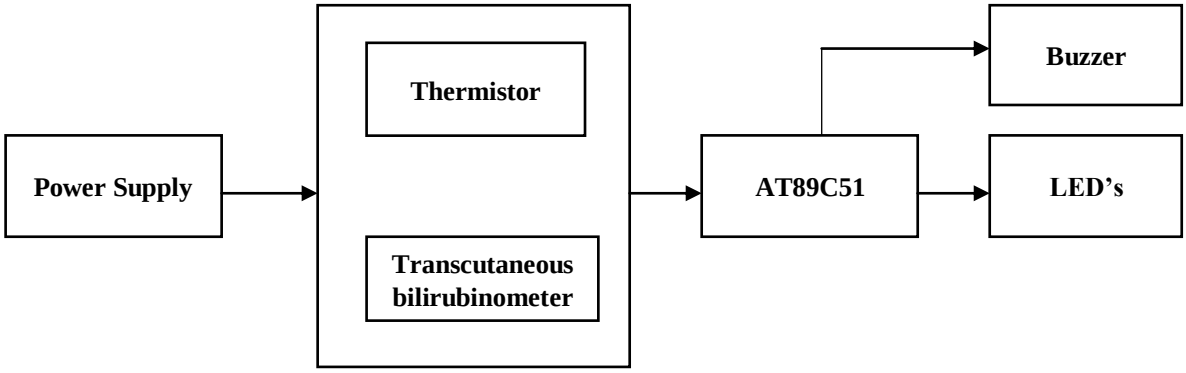

Fig. 1: Block Diagram of Proposed Method

2.6 Major Components

The Following are the major components used in this work

2.6.1 Microcontroller

A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller includes a processor, memory and input/output (I/O) peripherals on a single chip. In this work a AT89C51 Microcontroller is used. AT89C51 is an age old 8-bit microcontroller from the Atmel family. It works with the popular 8051 architecture and hence is used by most beginners till date.

2.6.2 Transformer

A transformer is a device used in the power transmission of electric energy. The transmission current is AC.

2.6.3 Thermistor

A thermistor (or thermal resistor) is defined as a type of resistor whose electrical resistance varies with changes in temperature.

2.6.4 Light Emitting Diode

A light releasing diode is an electric component that emits light when the electric current flows through it. It is a light source based on semiconductors.

2.6.5 Buzzers

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical or piezoelectric (piezo for short).

III. RESULT AND DISCUSSION

Before the microcontroller performs a series of processes, the first thing to do is initialize. The initialization of this program is to determine some input ports such as keypad and limit switches, outputs for Buzzer, LED. After the microcontroller initialization is complete, the bilirubinometer will make the reading of infants to make a decision that how many LED should be turned on, then the timer will estimate for 2 hours to feed a baby. The temperature sensor will follow up the baby to find dehydration. Dehydration can also be determined by various factors like urination and skin texture of the infant. If the infants is affected by dehydration, the body temperature will automatically go up. Thermistor will sense and then the LEDs are commented to off. Once the neonate is ready to treatment it can be continued. After regular treatment, if the bilirubin level decreases the LEDs will be automatically turned off.

3.1 Advantages

From the results of testing the system and process steps. This design can be more convenient and safe when compare to a phototherapy which are used in hospital. Though there are several modes and types of phototherapy devices available, based on the infant condition it will be selected. The advantages and features of the phototherapy process include

- Economical, Easy to diagnose.
- Regular monitoring of bilirubin level will decrease the risk of chronicity.
- The process of using a microcontroller that can be made and developed by anyone engaged in digital electronics.
- The design and process are still flexible and can be redeveloped according to the designer's wishes or needs.
- Using a thermistor to monitor the state of the baby's body temperature. It can reduce the risk of skin allergy or sikn rashes.
- Transcutaneous bilirubinometer are used to avoid pricking blood from the infant. Avoidance of blood wastage
- Feeding buzzer was fitted in the model to avoid dehydration. Dehydration can increase the comorbidity.
- Light-emitting diode (LED) lights are found in most new phototherapy units.
- Advantages include low power consumption.
- low heat production, and a much longer life span of the light-emitting units (20,000 hours) compared with older light sources

IV. CONCLUSION

Based on the results, we conclude that, the automated phototherapy model is designed to help in reducing neonate’s bilirubin range by exposing neonates under the light source with the bilirubinometer. The light source here used is LED. This transcutaneous bilirubinometer helps to detect the bilirubin range regularly in infants. Based on the bilirubin range, the intensity of light will change automatically. This device also have a thermistor to detect the infant temperature and automatically turn OFF when it encounter that the temperature

exceeds the normal range. It is necessary to feed a baby undergoing phototherapy once in every 2 hours to avoid dehydration so this device additionally has a buzzer which will alert every 2 hours to feed the neonate. In future, the distance between the neonate and LED can be automatically changed according to the serum bilirubin level.

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