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Direct Photometry Non Invasive Bilirubin Device

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Abstract - *Measurement of jaundice among neonates is important in determine the possible treatment to prevent any serious illness. Normally jaundice is checked by using invasive method; blood test and urine test. Invasive blood sampling is stressful for the neonate, resulting in blood loss and an increased risk for infections at the site of sampling. Direct Photometry Non Invasive Bilirubin Device will overcome the issues happened. Direct photometric measurements are based on direct measurements of suitably solved serum at the wavelength of 455nm, which is the absorption maximum of bilirubin. Direct photometry can be used only in newborns. The knowledge of light transmission and absorption on a specific tissue compartment is applied. The relevant skin photo diagnostics handle 575 nm (green) and 450 nm (blue monochromatic light). The device uses only one parameter which is reading of bilirubin in µmol/L. The output will appear on the LCD based on the level of bilirubin. It appeared as Normal (Green Light), Moderate (Yellow Light) and Critical (Red Light and Buzzer).*

Key Words: *arduino, bilirubin, non-invasive, photometry, wavelength*

1.INTRODUCTION

The development of new technology introduces the new model and method detection of jaundice or hyperbilirubinemia by using non-invasive method. The yellow discoloration is used to measure bilirubin concentration for determining the level of jaundice in infants[1]. Hyperbilirubinemia or Neonates Jaundice is commonly happened in the neonates or newborns due to rise in the amount of bilirubin concentration in the body. Non-invasive, transcutaneous, point of care measurement of transcutaneous bilirubin (TcB) pre-discharge by multi-wavelength spectral analysis, using a portable device is clinically equivalent to measurement of TSB in a diverse, multiracial term and near-term newborn population and predictive of subsequent hyperbilirubinemia [2]. Non-invasive bilirubin meter can overcome the problem when taking the blood from the neonates. It can be painless and user friendly to the user.

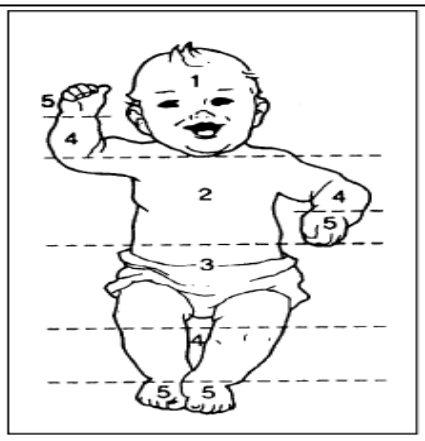
Direct photometry can be used only in newborns. In the case of most children and adults, the serum includes many other pigments of similar colors and reactions as bilirubin. The proposed benefits of using this technology include non-invasive and accurate screening for clinically significant jaundice. Transcutaneous Bilirubin readings are instant and results can avoid delay with discharge and or indicate the need for formal SBR testing [3]. Based on biomedical engineer and hospital staff's, providing a non-invasive method in detecting hyperbilirubinemia or jaundice can overcome some problem that may occurs during taking neonates blood. And can overcome mistake in prick needle among neonates. However, this non-invasive method which is the Direct Photometry Non Invasive Bilirubin Device must be calibrating to avoid from false readings and wrong indicator.

1.1 Bilirubin

Bilirubin is the yellowish pigment that is the byproduct of heme catabolism. Bilirubin is responsible for the yellow color of the urine. When the cell is died hemoglobin is release from the cell, which is breakdown into heme and globin. Heme is finally converting into bilirubin, an orange-yellow pigment. Bilirubin is an endogenous anion derived from hemoglobin degradation from the Red Blood Cell [4]. Bilirubin is altered by exposure to light so serum and plasma samples must be kept in dark before measurements are made. When the liver function tests are abnormal and the serum bilirubin levels more than 17µmol/L suggest underlying liver disease.

In a newborn, higher bilirubin is normal due to the stress of birth. Normal bilirubin in a newborn would be under 5 mg/dL, but many newborns have some kind of jaundice and bilirubin levels above 5 mg/dL [5]. If the blood tests show abnormally high levels of bilirubin, doctor may order more tests to determine the underlying cause. Once the doctor has determined a cause of high bilirubin levels, it may take more bilirubin blood tests to monitor the effectiveness of the treatment.

Table-1 : Correlation between icteric dermal zones (Kramer) and serum bilirubin values



Dermal Zone	Mean ± SD µmol/L
1	101 ± 5
2	152 ± 29
3	201 ± 31
4	257 ± 29
5	>257

Transcutaneous Bilirubinometry works by directing light into the skin of neonate and measures the intensity of specific part that is detected as shown in Table-1. The number of wavelengths, used is variable in different transcutaneous bilirubinometer. The meter analyzes the spectrum of optical signal reflected from the neonates subcutaneous tissues. These optical signals are converted to electrical signal by a photocell. These are analyzed by a microprocessor to generate a serum bilirubin value. This is hand held, portable and rechargable but expensive and sophisticated. When pressure is applied to the photoprobe, a xenon tube generates a strobe light; and this light passes through the subcutaneous tissue. The reflected light returns through the second fiber optic bundle to the spectrophotometric module. The intensity of the yellow color in this light, after correcting for the hemoglobin, is measured and instantly displayed in arbitrary units. Bilirubin concentration is measured by utilizing the entire spectrum of visible light (380 to 760 nm) reflected by the blood serum. This spectrum was received by the sensor and sent to PIC microcontroller in voltage form. The PIC analyzed accordingly as in Table-2 and the conditions applied are normal, mild and critical jaundice[6].

2.METHODOLOGY

Designation Direct Photometry Non Invasive Bilirubin Device of based on research that has been made by using several journals, lectures, biomedical engineers and hospital's staffs in Neonatal Intensive Care Unit (NICU). A decision has been made during the discussion in obtaining the proper and accurate readings of hyperbilirubinemia. The designation of new method of non-invasive bilirubin meter involves several important parts which are determining the wavelength LED which are 455 nm and 575 nm. 455nm functioning as absorption of maximum bilirubin. It is also can absorbs light. It comes in a blue color of LED.

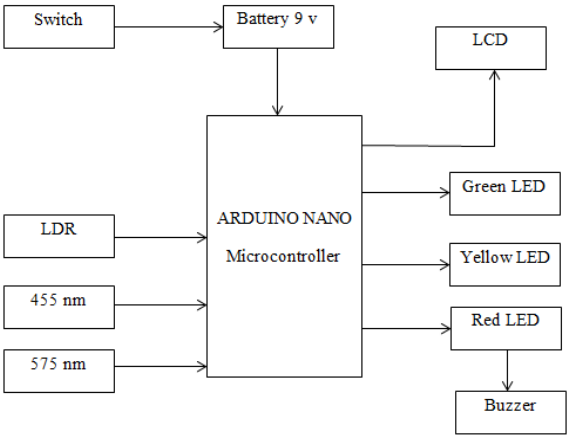


Fig -1: Block Diagram of Device

The other one LED that involves in wavelength LED is 575 nm. It is a monochromatic light. It is functioning as measuring bilirubin by detect spectral photometry. Based on the characteristics of this device, it must be suitable to detect the color of melanin which is the deep tissue in our body. Melanin means the pigment that gives human skin, hair and eyes their colors. Dark skinned people have more melanin in their skin than light skinned people have. Melanin is produced by cells called melanocytes. The project is divided into two parts which are hardware and software. The hardware part includes the circuit design for the spectrum LED to build the spectrophotometer sensor and the LCD display. While, the microcontroller had software part consists of the operational flow. The intensity of the yellow color in this light, after correcting for the hemoglobin, is measured and instantly displayed in arbitrary units.

This instrument was calibrated with test solutions and has a technical error of ±1.3% for values up to 350 µmol/L. Blue LED is called as 455 nm LED wavelength. It can absorb light through direct photometric method. Direct photometric measurements are based on direct measurements of suitably solved serum at the wavelength of 455nm, which is the absorption maximum of bilirubin. Direct measurements may be also interfered by opalescence

that results from the serum dilution or at the presence of oxy hemoglobin in the neonatal serum, which is often hemolytic and absorbs light at the wavelength of 455nm.

These interferences might be suppressed by a proper adjustment of the working process, by measurements taken at two wavelengths of 455 and 575nm. The bilirubin concentrations are found from the absorbency differences. The first one corresponds mainly to the bilirubin content and the second one to the oxy hemoglobin content[7]. A high quality device with a narrow definition of the monochromatic light must be used when measuring bilirubin by the direct spectral photometry. When calculating the concentration of bilirubin, we use the value of the molar bilirubin absorption coefficient. The molar absorption bilirubin coefficient ε is numerically equal to the bilirubin solution absorbency value having the concentration 1mol/L at a defined wavelength, temperature and layer width of 1cm.

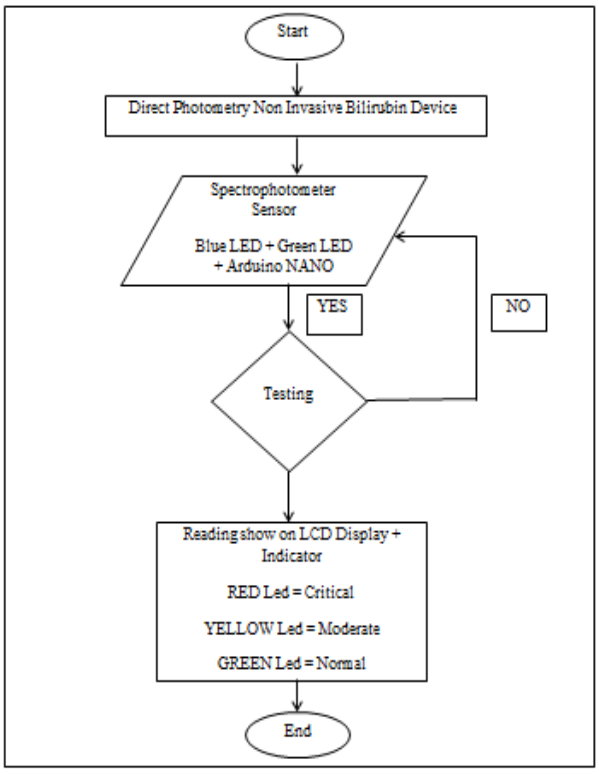


Fig-2: Flow Chart of Direct Photometry Non Invasive Bilirubin Device

Fig-3: Image of Direct Photometry Non Invasive Bilirubin Device

According to the Figure, it was implemented by three different colors of LED as indicator of the jaundice's readings. Red LED will show the higher readings of 359 µmol/L. Orange-yellow LED will indicate the moderate readings at range of 85 up to 323 µmol/L. Green LED will observe the low readings of jaundice at range of 0 to 85 µmol/L. The readings of jaundice will appear on the LCD Display.

3. RESULT AND DISCUSSION

This section discussed on the results. Data collection has been conducted to get the data non-invasive bilirubin device that has been produced. The range of condition was set according to normal, mild and critical as shown in Table-2 through the readings on Direct Photometry method (DPNIBD). Five samples have been taken to prove the concept Direct photometry system as shown in Table-3 with proportional Chart-1. Red LED was shown critical condition; Orange-yellow LED indicated moderate or mild condition; Green LED showed normal healthy condition. As a result this method is capable to give reasonable result and also give advantages to study the non-invasive system for measurement of jaundice level.

Table -2: Range of Condition

Condition	Serum Concentration (µmol/L)	Voltage Range
Normal	0 < thick < 85	4v - 6v
Mild	85<thick<323	2v – 4v
Critical	Thick > 359	0v – 2v

Table -3: Data Collection on five subjects

SUBJECT	DPNIBD (µmol/L)	Condition
1	334	Critical
2	328	Critical
3	167	Moderate
4	112	Moderate
5	84	Normal

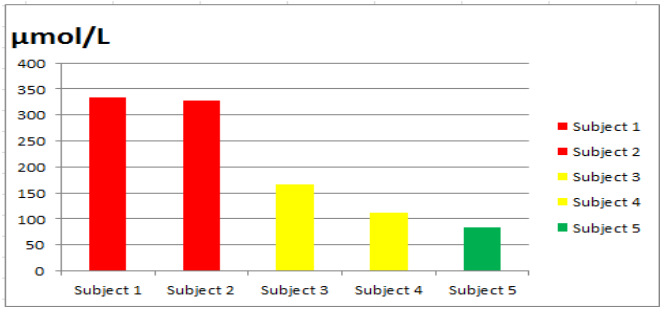


Chart -1: Bilirubin reading on Five Subjects

This paper presented data collected from direct photometry non-invasive bilirubin device that has been produced using spectrum LED. This innovation has created an alternative in getting painless bilirubin reading and reducing the usage of blood test and urine test. It can be concluded that the instrument that has been developed is accurate and reliable in measuring non – invasively bilirubin.

4. CONCLUSIONS

Detection of jaundice in early stage can be predicted by using invasive method. Due to demand in our latest technology and without painful, a new device is designed to determine jaundice by using direct photometry non-invasive bilirubin device which is more preferable and painless for testing to the baby. By using this non-invasive bilirubin device, it can save time, user friendly, affordable, painless and can make a harmony situation without any pricking needle is needed to determine the level or readings of the jaundice among baby. A system is developed in designation of spectrophotometer sensor by building two different wavelengths which are 455 nm and 575 nm. The device can indicates the three conditions of jaundice; normal, mild and critical level with LED light. This new technology of product can enlighten the effort of Pediatrics Units.

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BIOGRAPHIES

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