International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Hyperbilirubinema is Treated Using L.E.D Phototherapy for Neonatals

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Abstract: ***Neonatal hyperbilirubinemia or Neonatal jaundice is a yellowing of skin and other tissues of a newborn infant. Neonatal phototherapy is widely used and accepted form of treatment form of treatment for neonatal hyperbilirubinemia. Effective phototherapy needs to satisfy three important criteria: valuable spectrum, suitably high irradiance, and large efficient treatment area. In conventional method, different types of light sources are used, such as fluorescent lamps, quartz halogen lamps, gas discharge tubes etc. In this proposed method, we are using LED's are light source. These LED's are providing all the criteria for effective phototherapy. Comparing with the other conventional methods, this method will give a faster response for the breakdown of bilirubin. In this project, it is to create a LED phototherapy circuit unit having high competence, low thermal emission, and for extended term usage than other phototherapy methods.***

Keywords: Light-Emitting Diode (LED), Phototherapy, Bilirubin, Neonatal, icteric sclera

1. Introduction

A bilirubin level of more than 85umol/l (5mg/dL) manifests clinical jaundice in neonates [1]. In newborns, jaundice is detected by blanching the skin with digital pressure so that it reveals underlying skin and subcutaneous tissue. Jaundiced newborns have a visible icteric sclera, and yellowing of the face, extending down onto the chest [4]. In neonates, the dermal icterus is first noted in the face and as the bilirubin level rises proceeds caudal to the trunk and then to the extremities. This condition is common in newborns affect over half (50-60%) of all babies in the first week of life [3]. Infants whose palms and soles are yellow, have serum bilirubin level over 255umol/l (15mg/dL) are more serious level. In infants jaundice can be measured using invasive or non-invasive methods [1,5]. In non-invasive method Ingram icterometers and transcutaneous bilirubinometers are used.
Neonatal jaundice can be mainly classified into two types.
1.) Physiological jaundice
2.) Pathological jaundice
In neonates, jaundice tends to develop because of two factors – the breakdown of fetal hemoglobin as it is replaced with adult hemoglobin and the relatively immature hepatic metabolic pathways which are unable to conjugate and so excrete bilirubin as quickly as an adult [2,8]. This cause an accumulation of bilirubin the in the blood (hyperbilirubinemia), leading to the symptoms of jaundice. Severe neonatal jaundice may indicate the presence of other conditions contributing to the superior bilirubin levels, of which there is a large diversity of possibilities [3, 5]. These should be detected or excluded as part of the differential diagnosis to prevent the development of complications.

2. Materials and Methods

2.1 Non-Invasive Measurement of Jaundice Ingram Icterometers

In this method a portion of obvious plastic known as Ingram icterometers is used [1]. It is painted in five transverse strips of ranked yellow lines. The instrument is pushed against the nose and the yellow colour of the blanched skin is matched with the ranked yellow lines and bilirubin is assigned.

2.2 Transcutaneous Bilirubinometer

When pressure is practical to the photoprobe, a xenon tube engenders a light, and this light passed through the beneath the skin tissue. The reflected light proceeds through the second fibre optic bundle to the spectrophotometric module [6]. The intensity of the yellow colour in this light, after correcting for the haemoglobin, is measured and instantly displayed in arbitrary units.

2.3 Treatment

The bilirubin levels is varies depends on the age and the health of the newborn for initiating phototherapy. However any newborn with a total serum bilirubin greater than 359umol/l (21mg/dL) should receive phototherapy [1,3].
Phototherapy is the most effective way of breaking down a neonate's bilirubin. Phototherapy works through a method of isomerisation that changes transbilirubin in to the water soluble cisbilirubin isomer. In phototherapy, blue light is naturally used because it is more effective at breaking down bilirubin. Effective phototherapy needs to satisfy three important criteria: valuable spectrum, adequately high irradiance, and large efficient treatment area [7,8].

2.4 Valuable Spectrum

For phototherapy to be effective photons of light from the lamp must be absorbed by the bilirubin molecule. Bilirubin appears yellow because it strongly absorbs blue and green light. Blue light around 450nm is absorbed most readily if bilirubin is in a test tube. In a baby other factors including skin penetration and albumin binding, combine causing a colour shift of the most effective light towards the blue-green region.

2.5 Irradiance

Once an effective waveband has been found the light available must then be sufficiently intense, that is have a high enough irradiance, to produce an appreciable effect in reducing the neonate's bilirubin level. Higher minimum levels of irradiance have been proposed as more realistic in order to provide effective treatment. The irradiance of different phototherapy devices varies widely and is dependent on a number of factors, including the number of bulbs, tubes, or light sources, distance of the light source from the neonate and quality of the bulb or tube.

2.6 Efficient Surface Area

During phototherapy as much of the neonate's skin as possible should be illuminated by light of an effective waveband and sufficient irradiance. Illuminating as much skin surface area as possible has been shown to increase the speed of bilirubin clearance; that is increase it above the rate at which the bilirubin is produced by the infant, thereby producing a reduction in the overall bilirubin level [1,3].

3. Existing Method

3.1conventional Method

In conventional method, these devices use one or more tungsten halogen bulb, a metal halide gas discharge pipe, long or folded or compact fluorescent lamps. The light source is situated above or below the baby and the irradiance is dependent on the distance between the baby and the lights. The connection is related to the inverse square law, which is the intensity of the light decreases as the square of the distance. The decrease in irradiance with distance tends to be less because the light is rarely a point source. Obviously the closer the lights can be positioned to the infant the higher the irradiance, but care must be taken with the safety of such an arrangement to prevent overheating the neonate and also to ensure that as much of the infant's skin is illuminated as possible.

In its simplest form a conventional phototherapy device has a lamp head mounted on an adjustable mobile stand. The lamp may then position at a distance from the baby's sin. The minimum manufacturer usually specifies a minimum distance at which a device may be used and this can vary from 25 to50 cm.

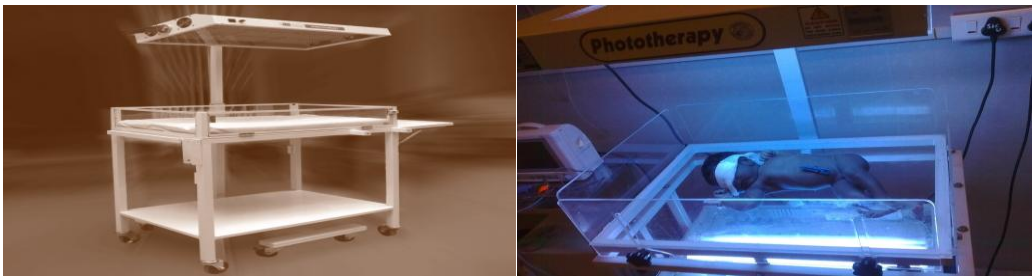

Figure 1: Single and Double Surface Conventional Phototherapy Unit

3.2 Proposed - LED Phototherapy Method

In this method we are using Light emitting diodes are the light sources. By using this power consumption can be reduced. It has an ideal irradiance levels. It is also having better optimal wavelength. The response level of LED's for treating jaundice is much faster than other conventional method. The life periods of the LED are much higher than other phototherapy methods [10].

Figure 2: LED Phototherapy Unit

3.3 Operation Principle

The skin over the entire body is radiated under phototherapy lights, except for their eyes and sex organs. In the condition the infant bares most skin and is wearing no clothing for warmth, the infant's body temperature may drop and body temperature must be maintained by other equipment, such as an incubator or heater. Make sure the infant is sound fed and that essential amounts of water are supported for the patient. The infant's eyes and sex organs must be covered before being radiated. Place the patient under the centre of the phototherapy lights and continuously change their posture every 2-3 hours. The distance from the phototherapy to the infant is not over 40 cm. A distance of 15-30 cm provides for better results. Follow up with the patient regularly during the process of treatment by phototherapy [10].

4. Phototherapy Indications

4.1 Indication

If the concentration of bilirubin continues to increase and there will be change in blood, it will lead safe for the patient. The concentration of bilirubin should especially be taken notice of with premature babies who weigh less than 1500gr, or risk serious harm from congestion. Exchange transfusion is needed to prevent quickly rising levels of bilirubin from causing hemolysis.

4.2 Contraindication

Jaundice is directly caused by increased levels of bilirubin. Jaundice is both directly and indirectly caused by increased levels of bilirubin. The safest treatment in both cases is an

exchange transfusion to avoid the skin from becoming bronze colored.

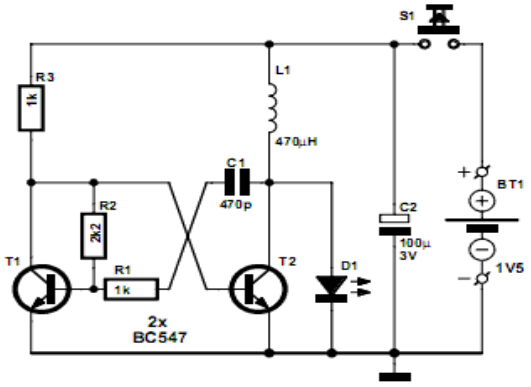

Figure 3: LED Phototherapy Unit Circuit Diagram

4.3 Principle Operating Guide

The result of handling using light depends on the following 3 main factors:

- Light vigor: based on the wavelength of the light source.
- Distance from phototherapy to patient (not to be over 40 cm, the distance of 15-30 cm provides best results).
- Array of skin contact to source of light: radiate both sides using a reflecting surface (aluminum board, silver paper) or mirror to increase the area of radiating light.

4.4 Technique

- Place infant in an incubator (for an infant under 35 weeks and below 2000 gr), under a warmer (for a baby over 35 weeks and more than 2000 gr) to sustain a proper body temperature of >36.5 C.
- Depiction as much of the infant's skin as possible (envelop eyes and sex organs).
- The infant should be completely bare except for thin loin-cloth so the skin of infant can be exposed to the light as much as feasible. Change the infant's position every 2-3 hours and ensure the infant's body temperature is maintained within the specified limits.
- Monitor the weight of the infant on a daily basis, supplement serum from 10-20% for a patient in an incubator, and 30% for a patient under a heater. Test the concentration of bilirubin following 12-24 hours [9].Breast-feed the infant.

5. Results and Discussion

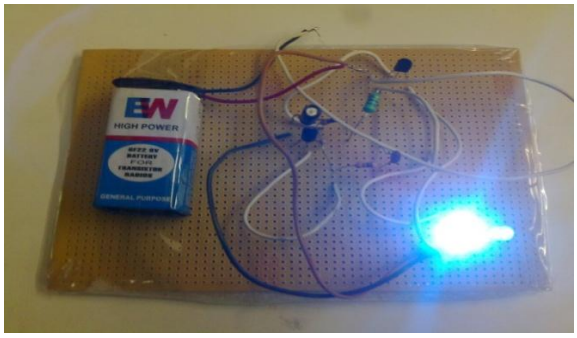

Figure 4: LED output received by using the demo circuit

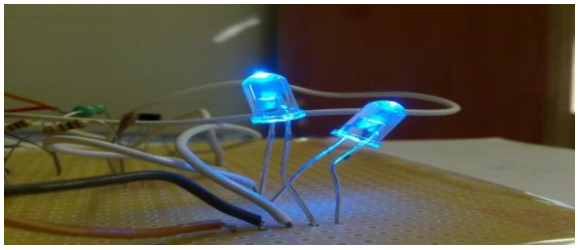

Figure 5: LED output

5.1 Method of Phototherapy

- Function: To generate an isomeric substance in the form of bilirubin (4Z-15E, Lumirubin) that is less toxic, electrically charged, and easy to eliminate (not by transforming liver).
- Kind of light: Blue lights with wave lengths of 400-500 nm are most effective in treating jaundice. The effective light spectrum curve. The best energy of light is 15-30(µWatt/n.mxcm2).
- Kind of lamp: LED Radiate both sides at the same time, radiate from above and below the body for excellent results.

Figure 6: Group of LED Output

6. Conclusions

The main goal of my project is to design and construct a phototherapy unit by using L.E.D has been effectively completed. The proposed system gives 92% less power consumption, long-term usage, low expenditure than other phototherapy units. In future this proposed system can be developed by using timer circuits, manual modes, and automatic timing mode and alarm generator.

References

[1] Madlon-Kay, Diane J. Recognition of the Presence and Severity of Newborn Jaundice by Parents ,Nurses , Physicians, and Icterometer Pediatrics 1997 100:e3
[2] Neonatal Jaundice Intensive Care Nursery House Staff Manual.UCSF Children's Hospital .2004.
[3] Harrison,K.L.(1979)."Fetal Erythrocyte Lifespan".Journal of Paediatrics and child Health 15.
[4] Obstetrics &Gynaecology,B.Jain in page no 45.
[5] McDonagh,A.F(2007)."Movement of Bilirubin and Bilirubin Conjugates Across the Placenta". Pediatrics 119(5)
[6] Health devices .Fiberoptic phototherapy systems. Health Devices 1994;24.
[7] DH.Neonatal phototherapy .A review including evaluations of ohmeda Biliblanket Plus and Medela

BiliBed. Evaluation 391.London :Medical Devices Agency(MDA).2000. 21
[8] Wentworth S .D.P.A study of neonatal phototherapy devices. Proceeding of the sixth Annual Scientific conference of the institute of Physics and Engineering in medicine.
[9] Newman T.B, Maisels M.J.Evaluation and treatment of jaundice in the term newborn:A kinder ,gentler approach.Pediatrics 1992;89.
[10] Dicken P,Grant L.J,Jones.S. An evaluation of the characteristics and performance of neonatal phototherapy equipment.Physiological Measurement 2000;21.
[11] Mr G.Ramachandran, Ms.T.Sheela, G.SureshKumar, Dr.T.Muthumanickam S.Kannan, S.Vaishnodevi: Application of Robot 2014 pageno-1