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EXAMINE THE EFFECT OF CHANGING TEMPERATURE AND HUMIDITY ON THE PATIENT WITH JAUNDICE PERIUD OF STAY INSID

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Abstract: Hyperthermia occurs during intensive phototherapy and disrupts treatment. Several studies have documented an increase in trans-epidermal water loss during phototherapy. The main goal of this study is to measure temperature and humidity by using Arduino uno system inside incubator and to find out whether there was an effect of these measurements on the period of patient's stay inside incubator. This is a descriptive cross-sectional case study done on 67 patients with neonatal jaundice who are stayed in incubators and undergoing phototherapy. This study conducted in Babylon Teaching Hospital for Maternity and Children, and Al-Noor Hospital for Children at the period from 1 April, 2022 to 1 May 2022. the temperature and humidity of 67 patients with jaundice was compared to the time spent in the incubator, Average humidity is higher significantly in relation to the increase length of stay in the incubator. When phototherapy is directed over an incubator, immediate and sustained fluctuations can occur in the thermal environment. Thermal instability can occur when using either the skin- or air-control mode of the incubator. Maintaining fluid balance by increasing incubator humidity might also be counterproductive, especially if high levels of humidity are used.

Key words: Humidity, Neonatal Jaundice, Phototherapy, Temperature.

Introduction:

Unconjugated Bilirubin is a toxic and insoluble product of heme catabolism that does not readily exit the body. Bilirubin leaves the body after binding to glucuronic acid in the liver to form a water-soluble compound (i.e. conjugated bilirubin), which can be excreted into the bile. Indirect hyperbilirubinemia is defined as an abnormally elevated concentration of unconjugated bilirubin in the blood. Neonatal hyperbilirubinemia occurs in the majority of newborns. Two concurrent factors contribute to this prevalence. Firstly, fetal erythrocytes are rapidly broken down shortly postpartum, resulting in a rapid production of unconjugated bilirubin. [1,2]

The highest level of spectral irradiance that can be safely used during intensive phototherapy is not established. Hyperthermia occurs during intensive phototherapy and disrupts treatment. Phototherapy is discontinued if body temperature becomes ≥37.5 °C. This may necessitate the use of more invasive treatments, such as exchange transfusion, and may put the patient at a higher risk for bilirubin neurotoxicity. A pediatric clinical investigation studied hyperthermia in neonates undergoing intensive blue light phototherapy. The study showed that there is a direct correlation between spectral irradiance and rise in body temperature of patients undergoing phototherapy. Moreover, the body temperature of every patient included in the study who was irradiated with blue light at a spectral irradiance ≥60 μW-cm-2 -nm-1 became ≥37.5 °C [4].Several studies have documented an increase in trans-epidermal water loss during phototherapy.[5] Excessive fluid losses via the skin are of particular concern in the smallest, most immature infants during the first week of life. These losses can be exacerbated by phototherapy.[6] Increasing fluid intake has been shown to shorten the duration of phototherapy in full-term neonates.[7] Some infants may experience intestinal fluid losses from a high volume of loose stools during phototherapy.

The suggested system used a group of sensors, some of which were used to measure patient specific (biological) parameters, and others were used to measure parameters specific to the environment surrounding the patient during the course of treatment. The purpose was to monitor the patient situation and determine the main effects that affect the treatment period.

Temperature Sensor

A temperature sensor is a device, typically, a thermocouple or RTD, which provides for temperature mensuration through an electrical signal. A thermometer is formed from two dissimilar metals that generate electrical voltage in direct proportion to changes in temperature. An RTD which is a variable resistor which will change its electrical resistance in direct proportion to changes in temperature in a precise, repeatable and nearly linear manner, see equation.

$$R = Rref\ [1+ \alpha\ (T - Tref)] \quad (2\text{-}1)$$

Where:

R: Conductor resistance at temperature T

$\boldsymbol{Rref}$: Conductor resistance at temperature $Tref$, usually, 20°C or 0°C.

α: Temperature coefficient of resistance for conductor material.

T: Conductor temperature in degrees Celsius.

$\boldsymbol{Tref}$: Conductor temperature which is 20°C or 0°C.

Humidity Sensor: Humidity is defined as a measure of the water vapor present in a gas. Two common parameters are related to humidity mensuration: absolute humidity (AH) and relative humidity (RH). Absolute Humidity (vapor density) is defined as a ratio of the mass of water vapor in air to the volume of air, with the unit of grams per cubic meter and determined by the equation.

The main goal of this study is to measure temperature and humidity by using Arduino Uno system inside incubator and to find out whether there was an effect of these measurements on the period of patient's stay inside incubator. The objectives to get out the outcomes are:

1. To design and fabricate the temperature and humidity sensors device.

2. To evaluate the designed sensors.

3. To measure the effect of temperature and humidity.

This is a descriptive cross-sectional case study done on new born patients with neonatal jaundice who are stayed in incubators and undergoing phototherapy. This study conducted in Babylon Teaching Hospital for Maternity and Children, and Al-Noor Hospital for Children at the period from 20 December 2021, to 21 April 2022.

The field of biomedical engineering, has become the link in the processes of detection, interpretation of diseases, and then the treatment and control the stages of the treatment . Jaundice is one of the common diseases in neonates, its principles causes and treatment are mentioned in Chapter Two. But now, we will be looking at the reason for the difference in the period of staying in the hospital for treatment, by studying a number of variables and parameters associated with the treatment process to achieve optimal conditions for successful treatment, save time and efforts. So, the data collected from the external sources, which are the incubators obtained using a variety of sensors. These sensors detected the environmental parameters, and biological parameters which obtained from the child itself. Then, it discusses the effect of the different parameters and extracts the necessary relationships among them and the impact on the speed of the healing process.

The suggested system includes the design of the sensing circuit. The electronic sensing circuit used to measure the variables associated with the treatment of patient of jaundice is divided into parameters related the environmental conditions of the incubator.

Methodology

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The System Design

1. **Temperature and Humidity sensor**

   This sensor is a device that can convert the amount of variables it senses into an electric signal that is easily measured. The sensor includes a capacitive sensor wet components and high-precision temperature measurement devices, and it connected with Arduino Uno microcontroller. The standard 3 – lead interface, system integration is quick and easy.

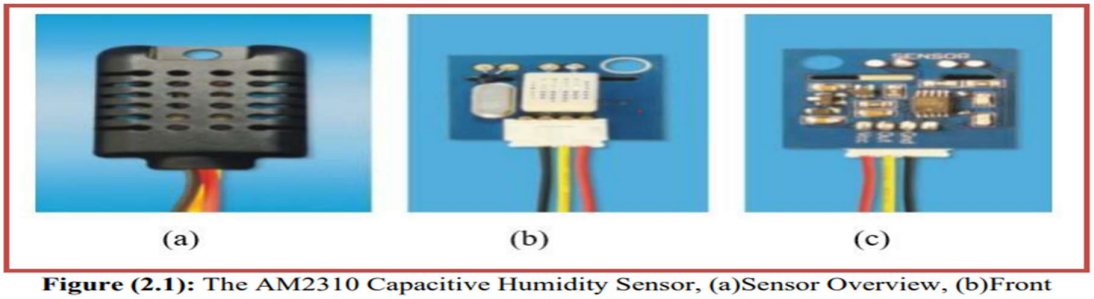
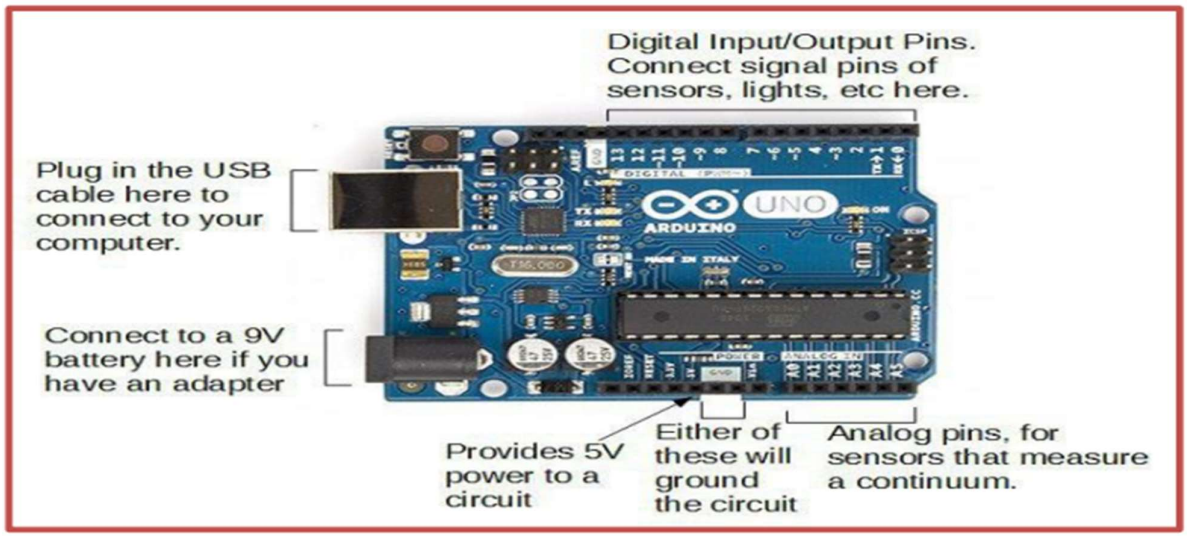


Figure (2.1): The AM2310 Capacitive Humidity Sensor, (a)Sensor Overview, (b)Front Side, (c)Back Side.

2. Arduino Uno

The Arduino Uno which is a microcontroller board grounded on the ATmega328 (datasheet) was selected as the microcontroller for this study. It comprises of 14 digital input/output pins (out of which 6 can be utilized as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a facilitation for USB connectivity, a power jack, an ICSP header and a reset button.



3. Display Unit

A control interface for a liquid crystal display having more than 80 characters uses a pair of controller/driver devices each having inputs for eight data bits but being adaptable to operate with four data bits from a 4-bit microprocessor.

4. Power Supply

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

Source of Information The source of information in the present system includes the data obtained from the hospital exactly from the patient file information such as: age, weight, gender, gestational age, blood group of mother, blood group of newborn, feeding type, patient period stay, patient temperature, TSB and PCV.

Readings Data

To facilitate the study and analysis of the data obtained, it can be included them in a statistical form named "Statistical form of neonatal jaundice patients" that contains three parts.

1.the environmental readings, which are the temperature, the oxygen ratio in the air, and the humidity are taken by placing the system inside the incubator and the sensors start to read the results and display them on the display unit.

2.Statistical Readings

Through the recorded readings of the variables obtained from the 67 children with jaundice, it can be found that there is a set of results that must be presented in a statistical way to get benefit from the final conclusions. The statistical reading according to the:

2.1.Age

2.2. Gestational Age

2.3. Weight

2.4. Gender

2.5. Feeding

Results and Discussion

The results of the Period of Patient Stay in Hospital Based on the Effect of Patient's and environmental Parameters**.**

Table (4-1): The distribution of patient and corresponding days in hospital

No. of Days Staying in Hospital	No. of Patients	Percentage of the Children Number (%)
1	9	13.4%
2	29	43.3%
3	14	20.9%
4	12	17.9%
5	1	1.4%
6	1	1.4%
7	1	1.4%
Total	67	100%

1. The Results of the Period of Staying in the Hospital Depending on the Effect of the Environmental Parameters.

Table .The period of staying in hospital according to the incubator temperature rate (°C) for all patients in this study.

NO.	Period of staying in hospital (day)	Incubator temperature rate ($°C$)
1	1	33.5-34.5
2	2	32.2-34.6
3	3	31.9-34.6
4	4	29.6-32.8
5	5	29.5-31.6
6	6	31-31.7
7	7	30-30.8

3.Patient Stay Period and Humidity in the Incubator

Table (3-3): The effect of humidity in the incubator on the staying of the patients and the period of staying them in the hospital

NO.	Period of Staying in Hospital (days)	Incubator Humidity Level (%)
1	1	45-49
2	2	47.2-50.6
3	3	43.16-49.6
4	4	31-35.75
5	5	31-33
6	6	30.7-35.7
7	7	30-33.5

Hence, 71% of the infants were treated and were in a good health within a short time (one to three days) while the rest were treated in longer time (in 4 to 12 days).The periods of hospitalization in children with jaundice vary according to the measured humidity values, as shown in the Table (4-3).

The variation of the humidity in the incubator generally affects the healing of jaundice patients and reduces their staying period in the hospital.[16]

The measurement system that used in this study enables a real perception of temperature and humidity in the incubator environment during the presence of the newborn with jaundice, thus the results obtained represent exactly the conditions experienced by the newborn with jaundice during the treatment, which directly affect the speed of treatment. [17]

To check the real readings of the proposed approach, the temperature and humidity of 67 patients with jaundice was compared to the time spent in the incubator is shown in Table (4-4), Which represent the relationship between the time which the child spent at the incubator and the incubator temperature (° C) and humidity range for all patients.

Average humidity is higher significantly in relation to the increase length of stay in the incubator. It is obvious that the changes in baby temperature and humidity from the mother's womb temperature and moist is considered as one of the conditions causing or helping diseases and therefore difficult to cure. It is clear that the patient stay period of the children with jaundice inside the incubator was closely related to the incubator's high humidity and temperature, for example the incubator temperature of the children who had been discharged in a one day period were at its average rates of 30.33° C, and humidity 27.33 g/m3. It was found that the speed of recovery for children with jaundice which the temperature and humidity in its incubator environment is higher than those no closer to the temperature of the mother's womb. This is due to the thermal regulation of the newborn inside the incubator is closer to the degree of the mother womb.[18-20]

Conclusions and Recommendations

1. Conclusions

1.1 **Temperature Effect**

It is clear that the staying of patient with jaundice in the hospital and inside the incubator was closely related to the incubator's temperature. It was found that the speed of recovery for children with jaundice which the temperature in its incubator environment is higher than those which had been treated in long period, because the temperature in their incubator are nearest to the temperature of the mother's womb. This is due to the thermal regulation of the newborn inside the incubator, which is closer to the degree of the mother womb.

1.2 Humidity Effect

It was concluded in the present study, as the relative humidity inside the incubator increased, the new born child with jaundice will recover faster than those with lower relative humidity inside the incubator. This is because of the fact that the rise of the relative humidity within newborn incubator reduced the loss of water for the skin of the newborns with fewer than thirty weeks of gestation and contributed to the maintenance of his corporal temperature.

2 .Recommendations

There are some recommended points further to the present study and suggested for future work as:

1. Develop the incubator system which were used in the present study by connecting to the computer to obtain continuous results throughout the period of staying in the hospital.

2. Modify new mathematical software to calculate the infant health and monitoring the incubator permanence.

3. Updating the current design by adding the continuous non-invasive bilirubin sensor to obtain continuous comparisons between the various variables and the bilirubin change.

4. Increasing the number of systems to be four installed on four incubators to increase the possibility of obtaining cases completely identical to increase the details and comparison and draw conclusions closer to accuracy.

5. Finally, uniform the incubator design according to the current finding to increase the infant recovery.

Conclusion: the effect of the temperature and humidity which are the most popular variable affected on the patient stay period in hospital. This situation places the newborn in a state of sudden environmental change which requires a necessary and quick adaptation.

Recommendation: This work opens the way for comprehensive study on the conditions affecting the temperature and humidity in the incubator to design an ideal incubator that provides ideal conditions that will help to actually reduce the treatment period for patients with jaundice.

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