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PROFILE OF HEMATOCRIT LEVEL CAPTURED BY DIGITAL HEMATOCRIT TEST

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ABSTRACT

The dengue fever is a disease caused by Dengue virus which is transmitted via *Aedes aegypti* and *Aedes albopictus* vector. This Dengue Haemorrhagic Fever (DHF) case in Indonesia tend to rise from year to year caused by delayed detection and inadequate handling. The laboratory parameter of hematocrit had regularly been performed using invasive method by taking the blood from the patient. This method is still not been able to monitor patients with DHF by repetitive and accurate measurement. This research project aims is to perform a digital hematocrit test (DHT) with non-invasive accurate sensors. Digital Hematocrit Test (DHT) is needed to presenting fast, exact, economical and accurate detection methods of hematocrit level. Measureable magnitude by the instrumentation is non-absorb intensity electromagnetic waves 560 nm emitted by transmitter captured by receiver. Signal captured by the receiver then converted into electrical signal. The electrical signal from receiver was the levels of hemoglobin. Levels of hemoglobin then converted to hematocrit. Hematokrit is three times the level of hemoglobin. Technology of hematocrit monitoring is aimed to control DHF patient clinical symptoms continuously and acqusitively.

Key words: Hematokrit (Hct), Hemoglobin (Hb), Wave 540–900 nm, Non invasive, Lambert Beer Law

ABSTRAK

Demam berdarah merupakan penyakit yang disebabkan oleh virus dengue yang ditransmisikan melalui *Aedes aegypti* dan *Aedes albopictus*. Kasus demam berdarah di Indonesia cenderung meningkat dari tahun ke tahun dikarenakan terlambat dideteksi serta penanganan yang kurang memadai. Parameter laboratorium dari hematokrit telah dilakukan menggunakan metode invasive dengan mengambil darah pasien. Metode ini masih belum bisa memonitor pasien dengan DBD melalui pengukuran berulang dan akurat. Penelitian ini bertujuan untuk menunjukkan tes hematokrit digital (THD) dengan sensor akurat yang non-invasif. Tes Hematokrit Digital (THD) diperlukan untuk menunjukkan deteksi yang cepat, tepat, ekonomis dan akurat dari kadar hematokrit. Besaran yang dapat diukur oleh instrumentasi ini adalah gelombang elektromagnetik 560 nm yang diemisikan oleh transmitter dan ditangkap oleh receiver. Sinyal yang ditangkap oleh receiver dikonversi menjadi sinyal elektrik. Sinyal elektrik dari receiver menggambarkan kadar hemoglobin. Kadar hemoglobin kemudian dikonversi menjadi hematokrit. Hematokrit merupakan tiga kali kadar hemoglobin. Teknologi memonitor kadar hematokrit bertujuan untuk mengontrol pasien dengan gejala klinis DBD secara berkelanjutan.

Kata kunci: Hematokrit (Hct), Hemoglobin (Hb), Gelombang 540–900 nm, non invasive, Lambert beer Law

INTRODUCTION

The dengue fever Dengue Hemorrhagic Fever (DHF) is disease caused by dengue virus transmitted through *Aedes aegypti* and *Aedes albopictus* mosquito. Both types of these mosquito are to be found almost in the whole parts of Indonesia, with the exception of a height more than 1000 meters above the sea level. Dengue fever disease often misdiagnosed by other diseases such flu or thypus. This is because an infection dengue virus that causes of dengue fever can be asimptomatik or obscure the symptoms. Based on child data of Cipto Mangunkusumo Hospital, dengue patients often showing symptoms such cough cold, vomiting, nausea and diarrhea. The problem might increase because the virus could enter at the same time with other disease such influenza or thypus. The understanding of disease infection by Dengue virus, pathogenesis, and clinical observation discernment. Using good and complete clinical examination supported by adequate laboratory examination then DHF diagnosis could be set up especially when symptoms are not enough.

The first time dengue fever in Indonesia was discovered in 1968, in Surabaya it happened in 1972. Since then, the disease spread across the area, until 1980 to every province in Indonesia. There were, for the first time show an increase of the number of cases in the area of or infected by or in a sporadic extraordinary occurrence always happening every year. The biggest extraordinary occurrence of DHF happened in 1998, with incidence rate (IR) = 35,19 per 100,000 population and CFR = 2%. In 1999, a sharp declination from 10,17%, but the next year is likely to increase from 15,99 (in 2000); 21,66 (in 2001); 19,24 (in 2002); 23,87 (in 2003).

The high prevalency of DHF could be caused by many factors. Delayed diagnosis, incautiousness of patients's family to monitor the physical symptoms and inadequate laboratory examination. The dengue diagnosis according of WHO criteria are thrombositopenia: < 100.000 mg/dl and hemoconsentration: Pack Cell Volume increase > 20%.¹ Hemoconcentration mean there was plasma leakage and it is main indicator to determine whether the patient already fall into Dengue Shock syndrome or not. There are several cause of inadequate detection of hematocrite by laboratory examination which could direct to false result such as first blood capillary contain interstitial liquid, sometimes blood specimen was not directly examine therefore could increase hematocrite level result, examination specimen was not mixed well until homogen, blood specimen could not contain clot.^{2,3}

Based on it above, test hematokrit digital (THD) is needed to presenting detection methods levels a hematocrit fast, exactly, economical and accurate. Magnitude measured by instrumentation system is non-absorb intensity of electromagnetic waves emitted by transmitter captured by receiver as the result the remaining non-absorb waves of 560 nm. Signal captured by receiver then converted into electrical signal. The electrical signal of receiver is showed

levels of hemoglobin in the veins. Levels of hemoglobin then converted to hematocrit level. Through the technology of this hematocrit level as an indicator plasma leakage could be monitor as often as possible continuously to prevent Dengue Shock Syndrome.

MATERIAL AND METHOD

Material

SpO₂ Oximetri Nellcor, LCD Graphic, arduino uno R3, Shield Arduino, Mini-LCD Probe, Baterai Li-Po 2200 mAh.

Method

SpO₂ Hardware accuracy

SpO₂ data accuracy by took the normal data patient to check accuracy and calibration. By connecting hardware shield with SpO₂ on arduino to ensure Red and IR in the right process.

Software Process and Filtering

Output SpO₂ data resulting from infra red (IR) and LED RED managed to find value intensity wide light absorb (R) on a finger/parts of patient bodies.⁴ Absorbs the intensity (R) may be known by measuring value AC_{red} and DC_{red} divided by value AC_{ir} and DC_{ir}, results either absorption managed to get a saturation oxygen (SaO₂) by dividing value HbO₂ with the result the number HbO₂ + Hb and multiplied 100%. Value Hb obtained by inserting value results saturation oxygen (SaO₂) by reduction constant value (110-25 x either absorption (R)) and multiplied by constants absorption Hb of 13.7. Value Hct is value 0.33 of the value Hb.

RESULT AND DISCUSSION

In this study, the average oxygen saturation measurement results of male samples with a DHT is 97.26% and in accordance with the normal range is 95–100% SpO₂ levels. Average Hb values of all the male data is 13.328 g/dl approaching the normal range of Hb values which is 13.5–18 g/dl for male.⁵ While the average male Hct value of all male samples is 39.976% approaching the normal range of Hct in male which are 40–54%.⁵

In this study also found the average measurement of the oxygen saturation results of female with a DHT is 97.5% which is in accordance with the normal range of female SpO₂ levels which is 95-100%. The average value of 13.326 g Hb/dl were in the normal range of hemoglobin values is 12-16 g/dl for female.⁵ While the average value of 40.1% of female Hct in appropriate range of normal values Hct 37–47% of female.⁵

Hematocrit (Hct) is an indicator of the determination of the most indicative of the symptoms of dengue fever.⁶

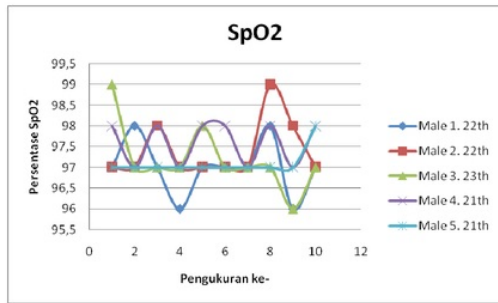


Figure 1. Percentage SpO2 of male

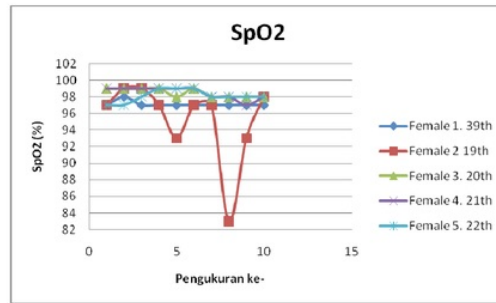


Figure 4. Percentage SpO2 of female

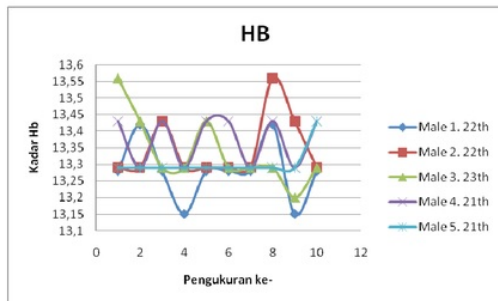


Figure 2. Hb level of male

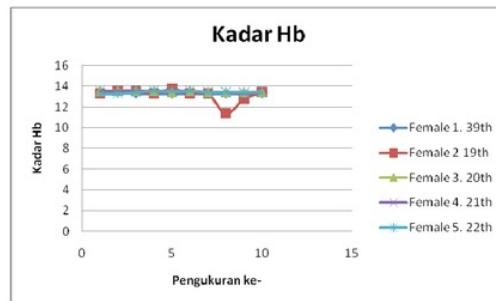


Figure 5. Hb level of female

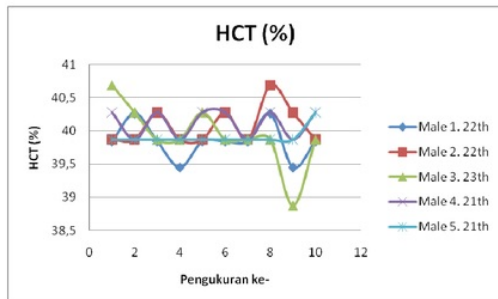


Figure 3. HCT of male

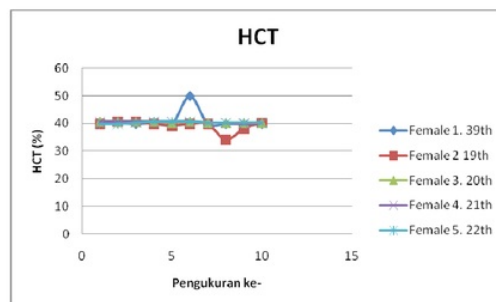


Figure 6. HCT of female

Initial hematocrit levels related to the degree of clinical DHF according to WHO criteria. Not only to assess the factual condition of the patient, but also to estimate or act as predictors the worst risk facing the patient, so it can be taken countermeasures and early prevention. As mentioned previously, plasma leakage is a causal factor that sparked the beginning of hypovolemia shock in dengue cases. And it has been proven that plasma leakage has occurred since the beginning of fever before the seizure.^{7,8,9}

Digital Hematocrit Test I (DHT) utilizing RED value at a wavelength of 540–900 nm and IR. HbO₂ and Hb values are the result of constituent values of saturation (SaO₂). To find the value of the voltage absorption wavelength

generated by HbO₂ and Hb should be based on the amount of voltage that is absorbed in the SpO₂. The division of red voltage value with IR voltage value generating absorption voltage values (R) which were used to search Hb value patient. Saturation value minus the result of filtering constantas (110-25 x absorption voltage (R)), hemoglobin (Hb) is obtained by multiplying the value of the saturation (SaO₂) to hemoglobin absorption constant value of 13.7. Percentage of HCT values obtained from 1/3 hemoglobin value.¹⁰

Average male HCT value 39,976% of all male data approaching the normal value range HCT for male which are 40 to 54%. The average value of female HCT 40.1% were

in the range of normal values female Hct 37–47%.⁵ Based on the results of measurements on male and female normal samples with 10 times showed that the measurement results are in accordance with the normal range of hematocrit values of male and female.

CONCLUSION

From the research it can be concluded that, a large percentage of the value of SpO₂ values can be used to find the value of Hb and Hct. The data obtained from the normal samples showed that SpO₂, Hb, and Hct value is still in the normal range.

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