Indonesian Journal of Electronics, Electromedical Engineering, and Medical Informatics
Multidisciplinary : Rapid Review : Open Access Journal Vol. 5, No. 2, May 2023, pp.86-91 e-ISSN: 2656-8624

RESEARCH ARTICLE OPEN ACCESS

Manuscript received December 31, 2022; revised January 21, 2023; accepted February 02, 2023; date of publication May 30, 2023
Digital Object Identifier (**DOI**): https://doi.org/10.35882/ijeeemi.v5i2.276

How to cite: Baharudin Adi Baharsyah, Endang Dian Setioningsih, Sari Luthfiyah, and Wahyu Caesarendra, "The Stability Value of The Dialysate Flow Rate was Investigated on the Hemodialysis Machine", Indonesian Journal of Electronics, Electromedical Engineering, and Medical Informatics, Vol. 5, No. 2, pp. 86-91, May. 2023

Analyzing the Relationship between Dialysate Flow Rate Stability and Hemodialysis Machine Efficiency

Baharudin Adi Baharsyah[1], Endang Dian Setioningsih[1], Sari Luthfiyah[1] and Wahyu Caesarendra[2]

[1] Department of Electromedical Engineering, Poltekkes Kemenkes Surabaya, Surabaya, Indonesia
[2] Universiti Brunei Darussalam, Gadong BE1410, Brunei Darussalam

Corresponding author: Sari Luthfiyah (e-mail: sarilut@poltekkesdepkes-sby.ac.id)

ABSTRACT Chronic kidney disease (CKD) is a condition characterized by impaired kidney function, leading to disruptions in metabolism, fluid balance, and electrolyte regulation. Hemodialysis serves as a supportive therapy for individuals with CKD, prolonging life but unable to fully restore kidney function. Factors influencing urea and creatinine levels in hemodialysis patients include blood flow velocity, dialysis duration, and dialyzer selection. This research aims to establish a standard for calculating the dialysate flow rate, thereby enhancing dialysis efficiency. The study employs a pre-experimental "one group post-test" design, lacking baseline measurements and randomization, although a control group was utilized. The design's weakness lies in the absence of an initial condition assessment, making conclusive results challenging. Measurement comparisons between the module and the instrument yielded a 5.30% difference, while the difference between the hemodialysis machine and standard equipment was 4.02%. Furthermore, six module measurements against three comparison tools showed a 0.17% difference for the hemodialysis machine with standard equipment, and a 0.18% difference for the module with standard equipment, with a 0.23% discrepancy between the two. Further analysis is necessary to understand the clinical significance and implications of these measurement variations on overall dialysis efficacy.

INDEX TERMS hemodialysis, dialysate, flow rate, flow sensor

I. INTRODUCTION

Chronic kidney disease is a malfunction of the kidneys in which the body's metabolism, fluid, and electrolyte balance are disrupted [1][2]. Kidney illness is one of the most expensive health problems in the world. One of the signs and symptoms of renal disease is the presence of urea in the blood [3][4][5]. Uremia is caused by the body's failure to maintain metabolic, fluid, and electrolyte balance as a result of gradual and irreversible kidney disease. Hemodialysis is a life-sustaining treatment for chronic renal failure [6][7]. This treatment can help the patient live longer, but it won't restore kidney function. Hemodialysis has been shown to benefit patients and improve their quality of life. Hemodialysis, a treatment activity done on individuals with chronic renal failure to survive, is used to provide kidney replacement therapy [8][9][10]. Hemodialysis is a treatment (replacement treatment) for patients with end-stage chronic kidney failure, in which the kidney function is replaced by a dialyzer, which performs a process of moving dissolved components in the blood into dialysis fluid or vice versa [11][12]. Hemodialysis is a method of changing the solute composition of the blood by the use of a semi-permeable membrane. Hemodialysis necessitates the use of a dialysis machine and a particular filter known as a dialyzer to clean blood. Blood is taken from the patient's body and circulated in a machine outside the body, and vice versa [9][11]. Hemodialysis involves cleaning blood through an ultrafiltration procedure, which results in a fluid transfer in the form of dialysate, water, and blood passing through a semipermeable membrane on the dialyzer [13][14]. As previously stated, hemodialysis is one of the renal replacement therapies for survival, thus its efficacy is critical. The efficacy of hemodialysis can be demonstrated in the decrease in urea and creatinine levels following hemodialysis [15][16]. The speed of blood flow, the duration of dialysis, and the dialyzer employed all affect the value of urea and creatinine in hemodialysis patients. For hemodialysis to be effective, monitoring and regulation are

required [17]. During the hemodialysis procedure, one of the critical settings is the regulation and monitoring of blood flow velocity[18]. The pace of blood flow is regulated by dialysate fluid, which is influenced by flow rate parameters, temperature, conductivity, dialysate pH, dialysate pressure, venous pressure, and arterial pressure to achieve the effectiveness of dialysate hemodialysis [19][20][21]. Because the bulk of sodium is expelled by convection in ultrafiltration during hemodialysis, adjusting the concentration from low to high seeks to maintain sodium balance [22]. The stability of the PH value, temperature, conductivity, and venous and arterial pressure is affected by the length of time spent on the hemodialysis machine. The hemodialysis machine is 5 years old (10.040 hours) each year [23][24]. The author of this study uses past research as a guide and benchmark for completing the study. Zhang introduced a hemodialysis machine calibration detector with various parameters based on a literature search in 2015, but there is no experimental technique or device that can be utilized to verify the accuracy and reliability of the hemodialysis machine detector [25].
There is no display designation indicator based on the outcomes of the above-mentioned problem identification, as evidenced by looking at the conditions, among other things. The purpose of this research is to establish a standardized method for calculating the dialysate flow rate in hemodialysis treatment, with the objective of improving dialysis efficiency. It is predicted that measuring according to criteria to promote the effectiveness of the dialysis process will be more practical and user-friendly. The contribution of this study is:

a. Highlighting the need for a standardized method to calculate the dialysate flow rate, which can enhance the efficiency of dialysis treatment.
b. Recognition of the weakness in the research design, emphasizing the importance of baseline measurements and randomization for obtaining conclusive results.
c. Measurement comparisons between different tools and equipment, reveal variations in percentage differences, which can contribute to the understanding of measurement accuracy and precision in hemodialysis.

II. MATERIALS AND METHODS

A. EXPERIMENTAL SETUP

Techniques The flow rate of dialysate is measured on a hemodialysis machine and connected to a calibrator module with a comparison tool for data gathering. A hemodialysis analyzer (IBP HDC 75) was used to measure the dialysis machine's dialysate flow rate, which was compared to standardized equipment. The flow rate of 500 ml/min was measured. At each measurement location, the findings will be recorded (six) 6 times.

1) MATERIALS AND TOOLS

A flow meter is a measuring tool that is used to determine the flow rate or volume of a moving fluid. The Hall effect sensor is used in the operation of this sensor. The Hall effect is a phenomenon that occurs when a magnetic field is applied to moving charged particles. The ESP32-WROOM-32 is a versatile Wi-Fi + Bluetooth + BLE MCU module that may be used in a variety of applications.

2) EXPERIMENT

Finding the reading value on the module and comparing it to the reading value on the comparator is how the dialysate rate is measured on the module and comparator. On a hemodialysis machine, the dialysate flow rate is 500 ml/minute. Six (6) measurements were carried out.

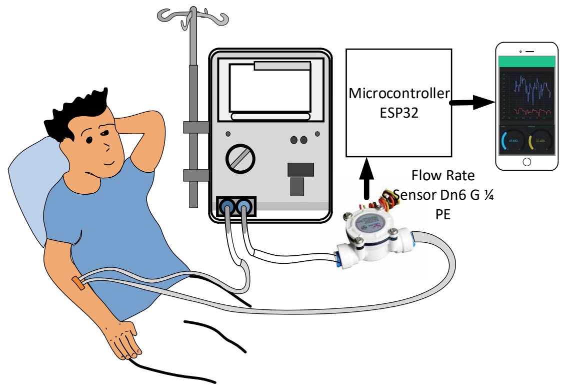

FIGURE 1. The Diagram Block

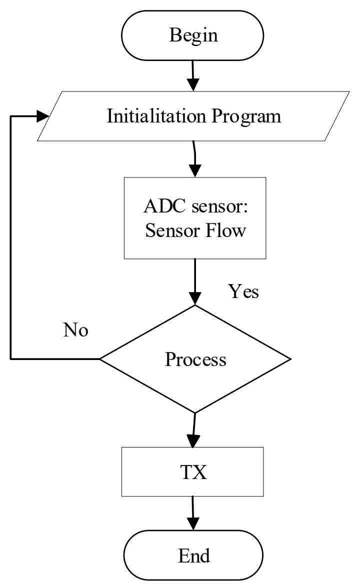

FIGURE 2. The Flowchart

B. THE DIAGRAM BLOCK

FIGURE 1 shows the battery serves as a voltage supply for all circuits. The Dn6 G 1/4 "PE Flow Pressure Sensor reads the value of the Tekn Dn6 G 1/4 "PE sensor's continuing flow rate output on the ADC ESP 32 pin. The Arduino's

ADC pin converts analog data to digital data. The ADC data is transformed into a flow rate value, which is subsequently sent through the Blink platform. The value of the sensor reading will be displayed on the blink platform.

C. THE FLOWCHART

FIGURE 2 shows when the tool is turned on, it will initialize before receiving ADC data from the flow, pH, and temperature sensors, which will be read and processed on the microcontroller and ESP32 before being sent to the Internet of Things platform. Android executes data initialization and then gets data from the ESP 32 via the Blink platform, where pH and Temperature data will be shown in FIGURE 3.

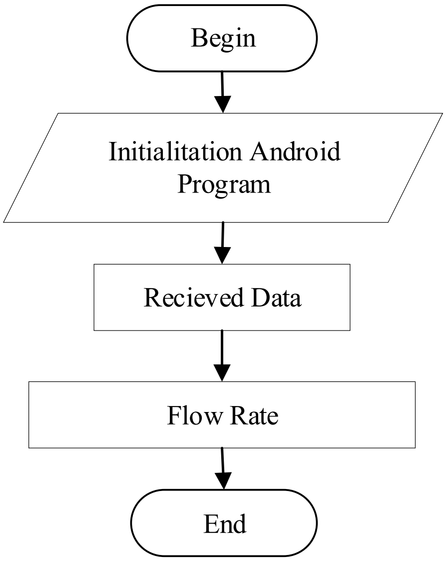

FIGURE 3. The Flowchart platform Blynk

III. RESULT

The average reading of the instrument, the standard deviation, the error value, and the measurement uncertainty of the acceptability defined by the reference standard are all part of the data processing.

FIGURE 4. Module design

A. DESIGN MODULE BUILD

When the switch is turned on, the tool begins to function by disconnecting the input voltage/VCC from all system components (FIGURE.4). The voltage from the +7.2V DC battery enters the Step-Down module, which reduces the voltage to +5VDC by converting it from 7.2 VDC to 5VDC. The VIN Esp32 supply and the VCC pin on the LCD are both powered by this +5VDC voltage. The LCD acts as a display for the dialysate flow value, which is then sent to the Blynk platform.

C. MEASUREMENT RESULT

Comparing hemodialysis machine modules by evaluating dialysate output using standard and traceable measurement devices. The flow setting in 500 mL with the module shown in TABLE 1. The flow setting in 500 mL with the standard tool is shown in TABLE 2. The flow setting in 524, 528, 531, 533, and 534 mL with the standard tool shown in TABLE 3.

TABLE 1.
Comparison of results from measurements

Flow setting 500mL			
No	Unit / ml	Module / ml	Minute
1	500	533	33
2	500	524	24
3	500	520	20
4	500	541	41
5	500	533	33
6	500	524	24

TABLE 2.
Results of measurement with trackable equipment

Flow setting 500mL			
No	Unit / ml	Standard Tool / ml	Minute
1	500	514	14
2	500	512	12
3	500	513	13
4	500	510	10
5	500	511	11
6	500	512	12

TABLE 3.
Results of measurement with trackable equipment

Flow setting 500mL			
No	Module / ml	Standard Tool / ml	Minute
1	534	514	20
2	524	512	12
3	528	513	15
4	531	510	21
5	533	511	22
6	533	512	21

D. RESULTS OF DATA ANALYSIS DISCUSSION

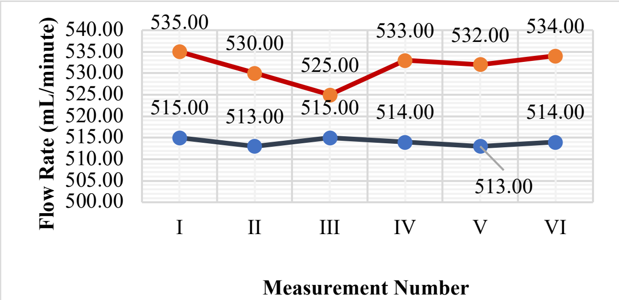

FIGURE 5. Measurement of dialysate flow rate vs. post comparison tool on 1 machine (red line is the proposed design and the black line is the calibrator)

The tool module recorded a value of 535.00 mL/minute in the first measurement, while the comparison tool recorded a value of 515.00 mL/minute shown in FIGURE 5.

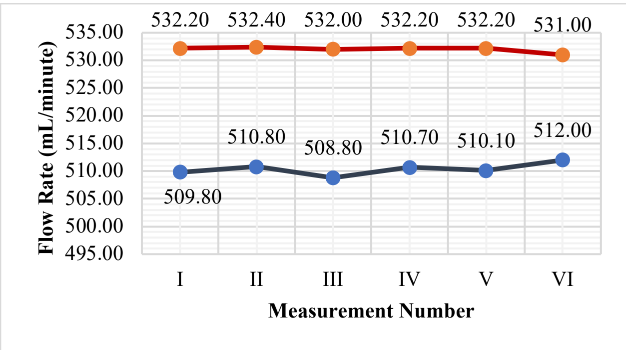

FIGURE 6. Measurement of dialysate flow rate versus post-comparison tool on 2 machines (the red line is the proposed design and the black line is the calibrator)

The tool module recorded a value of 530.20 mL/minute in the second test, while the comparison tool recorded a value of 518.50 mL/minute shown in FIGURE 6.

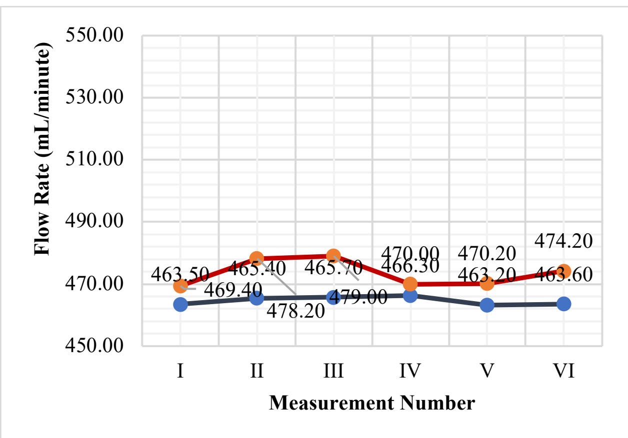

FIGURE 7. Measurement of dialysate flow rate versus post-comparison tool on 3 machines (red line is the proposed design and the black line is the calibrator)

The tool module recorded a value of 479.00 mL/minute in the third measurement, while the comparison tool recorded 465.70 mL/minute shown in FIGURE 7.

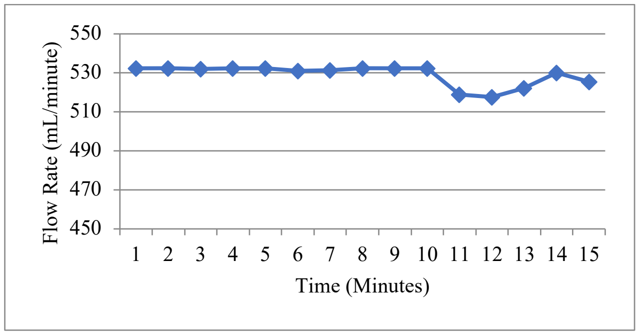

FIGURE 8. Dialysate flow rate measurement graphed against machine 1 in Minutes

For module readings, the lowest value was 517.60 mL/minute and the highest value was 532.40 mL/minute on the measurement chart at the 500 mL/min measuring point. The values in the output data are still within the tolerance range shown in FIGURE 8.

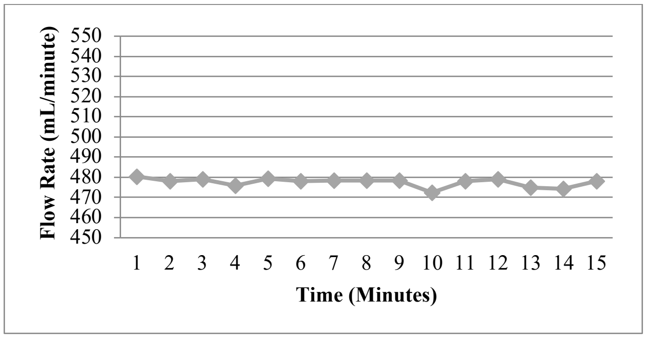

FIGURE 9. Dialysate flow rate measurement graphed against machine 2 in minutes

For module readings shown in FIGURE 9, the measurement chart yielded the lowest value of 472.40 ml/Min and the highest value of 480.40 ml/Min at the 500 ml/Min measuring point. The output data remains within the acceptable range of values.

IV. DISCUSSION

Using Esp32 and IOT Blynk to display the measurement results on Android, a module can be created to determine the flow rate value on an Internet of Things (IoT) based hemodialysis equipment. The tool module recorded a value of 479.00 mL/minute in the first measurement, while the comparison tool recorded 462.60 mL/minute. The tool module recorded a value of 470.20 mL/minute in the second test, while the comparison tool recorded a 464.40 mL/minute value. The tool module recorded a value of 479.00 mL/minute in the third measurement, while the comparison tool recorded 465.70 mL/minute. The tool module recorded a value of 448.00 mL/minute in the fourth measurement, while the comparison tool recorded a value of 434.30 mL/minute. The tool module recorded a value of 479.20 mL/minute in the fifth measurement, while the comparison tool recorded a value of 463.20 mL/minute. The tool module recorded a value of 470.00 mL/minute in the sixth measurement, while the comparison tool recorded 463.60 mL/minute. The lowest value for module readings was 434.50 mL/minute and the maximum value was 479.00 mL/minute, whereas the lowest value for the comparison tool reading was 448.00 mL/minute and the highest value was 463.20 mL/minute.

This study's findings significantly surpass those of previous research, representing a substantial breakthrough in the field. The results obtained have far-reaching implications, particularly in the realm of calculating the flow rate value on an Internet of Things (IoT)-based hemodialysis machine that integrates hemodialysis [19][20] [26]. n addition to the groundbreaking findings, this study has also unveiled certain deficiencies that warrant attention and subsequent improvements. Notably, it has identified the pressing need for program enhancements to ensure heightened accuracy in the calculations. Furthermore, refining the parameters of the measuring instrument is essential to optimize its performance. Another key aspect that emerged from this research is the importance of incorporating storage capabilities for measurement results on the device, which can be achieved through the use of an SD card. Additionally, exploring the possibility of directly displaying the calibration sheet results on the web would enhance accessibility and convenience. By addressing these identified flaws and implementing the recommended improvements, the overall functionality, precision, and user experience of the hemodialysis machine can be significantly enhanced. This research's data from sensor readings can be used to determine how the value of the dialysate flow rate can be determined according to a standard to support the dialysis process' effectiveness, which should be more practical and user-friendly. So that the patient-handling process can be completed properly.

Based on the results and discussion above, it can be found that the weaknesses and limitations of this study are the lack of information provided about the sampling method or selection of participants. In future research, it is necessary to make clearer boundaries regarding sampling methods so that it can be understood that the samples used in this study represent the relevant population and about sampling methods that meet the required accuracy and reliability criteria. In addition, there is no discussion of the validity and reliability of the module and comparison devices used to measure dialysate flow. The validity and reliability of these tools are important factors in determining the accuracy and reliability of the measurement results. A further weakness of this study is that no statistical analyses were performed to evaluate the differences between the values recorded by the module device and the comparison device. This is very important to know whether these differences are statistically significant or just random variations. Furthermore, there is a lack of discussion on factors that might influence the difference in values between the module tool and the comparison tool. For example, environmental factors or technical factors that may affect the measurement results. Another weakness of this study is that there was no comparison with previous studies or with existing standards in the field of hemodialysis. This may help provide further context on the strengths or weaknesses of the results. Based on the aforementioned weaknesses, it is recommended to provide more complete information about the research methods, validity, and reliability of the tools used, relevant statistical analyses, as well as consider potential factors that may affect the measurement results.

The implications of the results of this research are as follows significant advances in the field of determining the value of dialysate flow rate in the Internet of Things (IoT)-based hemodialysis machines using Esp32 and IOT Blynk modules. The results of this study indicate the possibility of developing a module that can be used to measure dialysate flow with a high degree of accuracy. In addition, shortcomings were identified in this study, such as the need for program improvements to increase measurement accuracy, the need for parameter improvements to the measuring instrument, and the importance of storing measurement results on the device using an SD card. These findings indicate the direction of development and performance improvement of hemodialysis devices. Next, the extensive long-term implications of calculating dialysate flow rate values on IoT-based hemodialysis machines that integrate hemodialysis. With improved accuracy and device performance, the dialysis process can become more effective and efficient, which can provide significant benefits to patients. Finally, the potential use of data from sensor readings in this study to determine how dialysate flow rate values can be determined by existing standards, thus supporting the effectiveness of the dialysis process in general. This could contribute to the development of more practical and user-friendly patient care practices.

V. CONCLUSION

The purpose of this research is to determine how the value of the dialysate flow rate can be determined according to a standard to support the dialysis process' effectiveness, which should be more practical and user-friendly. The tool module recorded a value of 479.00 mL/minute in the first measurement, while the comparison tool recorded 462.60 mL/minute. The tool module recorded a value of 470.20 mL/minute in the second test, while the comparison tool recorded a 464.40 mL/minute value. Error data from the comparison tool and the calibrator module are compared. The largest error value is 4.02 percent at the measuring point of 500 ml/minute, while the lowest error value is 1.91 percent when utilizing a comparison tool. The hemodialysis machine with standard equipment is 0.17 percent, and the module with standard equipment is 0.18 percent, based on the results of six measurements of the module against three comparison tools, with the difference between the measurement of the module and the instrument being 0.23 percent. For further research, it is hoped that the measurement data on the instrument can be saved and included with the SD card, and the findings of the calibration sheet are also directly displayed on the web to support better research in the future.

REFERENCES

[1] F. Husain, H. Kusuma, and A. Johan, "Effects of Peer Support Program on Self-Management in Patients with End-Stage Renal Disease Undergoing Hemodialysis," *J. Nurs.*, vol. 10, no. 2, pp. 171–181, 2020, doi: 10.14710/nmjn.v10i2.26502.

[2] M. Rocco *et al.*, "KDOQI Clinical Practice Guideline for Hemodialysis Adequacy: 2015 Update," *Am. J. Kidney Dis.*, vol. 66, no. 5, pp. 884–930, 2015, doi: 10.1053/j.ajkd.2015.07.015.

[3] P. F. Wiliyanarti, D. Komunitas, and S. Majapahit, "Life Experiance Of Chronic Kidney Disease Undergoing Hemodialysis," *NurseLine J. Vol. 4 No. 1 Mei 2019 p-ISSN 2540-7937 e-ISSN 2541-464X*, vol. 4, no. 1, 2019.

[4] A. Anjarwati *et al.*, "Health Related-Quality of Life in CKD and Dialysis Patients in Asian Countries : A Systematic Review," *J. ARKESMAS*, vol. 3, no. 2, pp. 50–55, 2018.

[5] Z. L. Dewi, "Exploring Self-Regulation of Patients with Chronic Kidney Disease Undergoing Hemodialysis," *J. Pshychology*, vol. 48, no. 2018, pp. 1–15, 2021, doi: 10.22146/jpsi.61144.

[6] D. A. Pradila, M. P. Satiadarma, and U. S. Dharmawan, "Resilience of Elderly Patients with Chronic Kidney Disease Undergoing Hemodialysis," *J. Fac. Psychol. Tarumanagara Univ.*, vol. 6, pp. 1–6, 2013.

[7] N. K. Maurya, "A REVIEW : NUTRITION IN CHRONIC KIDNEY DISEASE PATIENTS : International Journal of Advance and Innovative Research International Journal of Advance and Innovative Research," *Int. J. Adv. Innov. Res.*, vol. 5, no. 3, pp. 97–108, 2018, doi: 10.5281/zenodo.1423081.

[8] J. B. Chen, K. C. Wu, S. H. Moi, L. Y. Chuang, and C. H. Yang, "Deep learning for intradialytic hypotension prediction in hemodialysis patients," *IEEE Access*, vol. 8, pp. 82382–82390, 2020, doi: 10.1109/ACCESS.2020.2988993.

[9] W. M. Azhar Bin Wan Ibrahim, "Conceptual design of blood pressure monitoring for old haemodialysis machine," in *International Conference on Computer Medical Applications, ICCMA 2013*, 2013, pp. 1–5, doi: 10.1109/ICCMA.2013.6506153.

[10] Y. T. Wulansari, "DESCRIPTION OF DEPRESSION SYMPTOMS IN HEMODIALYSIS PATIENTS AT," *J. Epidemiol. Dep. Fac. Public Heal.*, no. July 2019, pp. 304–314, 2020, doi: 10.20473/ijph.vl15il.2020.304-314.

[11] S. Mandolfo, F. Malberti, E. Imbasciati, P. Cogliati, and A. Gauly, "Impact of blood and dialysate flow and surface on performance of new polysulfone hemodialysis dialyzers," *Int. J. Artif. Organs*, vol. 26, no. 2, pp. 113–120, 2003.

[12] M. Faye *et al.*, "Manual Individualization of the Dialysate Flow According to Blood Flow : Effects on the Hemodialysis Dose Delivered and on Dialysate Consumption," *reserach Sq.*, vol. 6, pp. 1–5, 2020.

[13] M. A. Ramón *et al.*, "Original article What is the optimum dialysate flow in post-dilution online haemodiafiltration ? ☆," *Nefrol. (English Ed.*, vol. 35, no. 6, pp. 533–538, 2016, doi: 10.1016/j.nefroe.2015.04.005.

[14] R. Mcquillan, L. Trpeski, S. Fenton, and C. E. Lok, "Modifiable Risk Factors for Early Mortality on Hemodialysis," *Int. J. Nephrol.*, vol. 2012, p. 6, 2016, doi: 10.1155/2012/435736.

[15] M. H. Lai, H. M. Nieh, T. P. Teng, J. J. Chen, Y. Y. Huang, and Y. C. Lu, "Development of an hemodialysis simulator for interdisciplinary learning," in *2010 IEEE International Conference on Industrial Engineering and Engineering Management*, Dec. 2010, pp. 2493–2497, doi: 10.1109/IEEM.2010.5674325.

[16] R. DeCarlo and C. Meirina, "Parameter identification and adaptive control of an ultrafiltration process in hemodialysis," in *Proceedings of the American Control Conference*, 2000, vol. 5, no. June, pp. 2967–2971, doi: 10.1109/acc.2000.879109.

[17] R. A. Sherman, E. F. Faustino, A. S. Bernholc, and R. P. Eisinger, "Effect of Variations in Dialysate Temperature on Blood Pressure During Hemodialysis," *Am. J. Kidney Dis.*, vol. 4, no. 1, pp. 66–68, Jul. 1984, doi: 10.1016/S0272-6386(84)80029-3.

[18] T. Brown and A. S. Moore, "peak technique Hemodialysis : Step by step," no. February, pp. 21–24, 2020.

[19] P. E. Pérgola, N. M. Habiba, and J. M. Johnson, "Body temperature regulation during hemodialysis in long-term patients: is it time to change dialysate temperature prescription?," *Am. J. Kidney Dis.*, vol. 44, no. 1, pp. 155–165, Jul. 2004, doi: 10.1053/j.ajkd.2004.03.036.

[20] M. Robson, D. G. Oreopoulos, S. Izatt, R. Ogilvie, A. Rapoport, and G. A. Deveber, "Influence of exchange volume and dialysate flow rate on solute clearance in peritoneal dialysis," *Kidney Int.*, vol. 14, no. 5, pp. 486–490, 1978, doi: 10.1038/ki.1978.153.

[21] M. Hauk, M. K. Kuhlmann, W. Riegel, and H. Köhler, "In vivo effects of dialysate flow rate on Kt/V in maintenance hemodialysis patients," *Am. J. Kidney Dis.*, vol. 35, no. 1, pp. 105–111, 2000, doi: 10.1016/S0272-6386(00)70308-8.

[22] R. M. Hakim, M. A. Pontzer, D. Tilton, J. M. Lazarus, and M. N. Gottlieb, "Effects of acetate and bicarbonate dialysate in stable chronic dialysis patients," *Kidney Int.*, vol. 28, no. 3, pp. 535–540, 1985, doi: 10.1038/ki.1985.161.

[23] J. Stenberg, D. Keane, M. Lindberg, and H. Furuland, "Systematic Fluid Assessment in Haemodialysis: Development and Validation of A Decision Aid," *J. Ren. Care*, vol. 46, no. 1, pp. 52–61, 2020, doi: 10.1111/jorc.12304.

[24] L. Dai *et al.*, "Impact of twice- or three-times-weekly maintenance hemodialysis on patient outcomes," *Med.*, vol. 20, no. November 2019, 2020.

[25] P. Zhang, J. Sun, G. Wan, and W. Liu, "Primary design of hemodialysis machine detector calibration equipment," in *2015 8th International Conference on Biomedical Engineering and Informatics (BMEI)*, Oct. 2015, pp. 376–380, doi: 10.1109/BMEI.2015.7401533.

[26] M. K. Smolek, S. D. Klyce, and J. K. Hovis, "The Universal Standard Scale: Proposed improvements to the American National Standards Institute (ANSI) scale for corneal topography," *IVth Annu. Congr. Res. Refract. Eye Surg. Technol. Ft. Lauderdale,* vol. 109, no. 2, pp. 361–369, 2002, doi: 10.1016/S0161-6420(01)00888-0.

APPENDIX

```
#define SENSOR  27
long currentMillis = 0;
long previousMillis = 0;
int interval = 1000;
boolean ledState = LOW;
float calibrationFactor = 7.5;
volatile byte pulseCount;
byte pulse1Sec = 0;
float flowRate;
unsigned long flowMilliLitres;
unsigned int totalMilliLitres;
float flowLitres;
float totalLitres;
float hasilflow;
float hasilflow1;
void IRAM_ATTR pulseCounter()
{
  pulseCount++;//counter Flow
}
    pulse1Sec = pulseCount;
    pulseCount = 0;
flowRate = ((1000.0 / (millis() - previousMillis)) *
pulse1Sec) / calibrationFactor;
    previousMillis = millis();
    flowMilliLitres = (flowRate / 60) * 1000;
    flowLitres = (flowRate / 60);
    totalMilliLitres += flowMilliLitres;
    totalLitres += flowLitres;
    hasilflow1=float(flowRate)*1000;
    hasilflow=hasilflow1/10;
    Serial.print("Flow rate: ");
    Serial.print(hasilflow);
    Serial.print("L/min");
    Serial.print("\t");
Blynk.virtualWrite(V1,hasilflow);
  lcd.setCursor(0,2);
  lcd.print("Flow:");
  lcd.setCursor(5,2);
  lcd.print(hasilflow,2);
   lcd.print("mL/M");
  delay(500);
```

ATTACHMENT

- Schematic and Board : https://drive.google.com/drive/folders/1SkdQg2P5CwrOqwV27zwA1YFXwEFQ69vb?usp=sharing
- Listing Program : https://drive.google.com/drive/folders/1SkdQg2P5CwrOqwV27zwA1YFXwEFQ69vb?usp=sharing