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Monitoring System Design Gravimetric Anesthetic Dose

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Abstract

Anesthesia is a very important step in surgery. Research on the fulfillment of the ideal criteria for anesthetic techniques continues. These inhalation anesthetics require slow induction times, are complex and expensive devices and cannot be performed if veterinary surgery is performed in the field. In this study, the technique used was anesthesia through gravimetric infusion. The purpose of this study was to monitor the dose of gravimetric infusion anesthesia using a load cell. The load cell sensor will send data to the NodeMCU to display the anesthetic dose that has been entered on the smartphone. The results of the gravimetric infusion anesthetic dose monitoring system produced a very small error of 0.004%. The error in reading the anesthetic dose is very important because the main factor of this gravimetric infusion anesthetic is the right dose to meet the criteria for ideal anesthesia.

Keywords: *Anesthesia, Infusion, Internet of Thing, Load Cell*

1. Introduction

Anesthesia is an important action in surgery on patients. Research on anesthetic techniques continues to develop to achieve the ideal criteria for anesthesia, namely anesthesia that produces analgesia, sedation, relaxation and produces an unconscious state, is safe for vital systems and is easy to apply. Surgery in animals generally uses inhalation anesthetics. This type of anesthesia requires slow induction times, complex and expensive devices and cannot be performed if veterinary surgery is performed in the field. Inhalation anesthetics using halothane can cause exposure to the room and cause liver problems [1]. Meanwhile, if the substance used in inhalation anesthetics with nitrogen oxides is evaporated with halogens, it can pollute the air and reduce the ozone layer [2]. Anesthesia via intramuscular or intravenous injection is difficult because some animals are very difficult to restrain. Therefore, the anesthetic technique needed is an anesthetic with a fast onset and a small volume of administration, and can provide a hypnotic effect as well as analgesia [3]. The anesthetic method that is easier and more practical is the gravimetric method. The gravimetric method of anesthesia is an anesthetic method through the injection of intravenous infusion drops that are given repeatedly. The advantage of this anesthetic method is that the anesthetic status obtained is the same as inhalation anesthesia at a lower cost. This anesthetic uses the parenteral gravimetric infusion method on a continuous intravenous basis with a predetermined infusion rate [2].

The purpose of this study was to monitor the amount of anesthetic fluid in the infusion fluid according to the predetermined dose. The number of anesthetic doses to be mixed in infusion fluids was not discussed in this study. The monitoring system for the amount of anesthetic infusion fluid uses a load cell sensor. The load cell sensor is a transducer that works as a conversion of the weight of the object into electricity, this change occurs because there is resistance in the strain gauge. Monitoring of intravenous fluids in patients

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is important for patients. To facilitate monitoring of infusion fluids in patients in each hospital patient room, the web is used [4],[5]. Monitoring of infusion fluids using Internet of things technology is also carried out to make it easier for nurses to control infusion fluids in a ward in a control room [6],[7]. Research on the number of intravenous fluids given to patients is also important. The use of a DC motor to regulate the rate of drip infusion has been carried out with the minimum number of drops being 8 drops/minute and the maximum number of drops that can be adjusted is 50 drops/minute with an error of 2% per minute [8]. The photodiode sensor is used to calculate the number of drops of infusion fluid with an error of 0.05% but cannot adjust the number of drops needed [9].

2. Research Methodology

The gravimetric anesthesia hardware consists of a load cell sensor, module HX711, NodeMCU, and ESP 8266 as shown in the block diagram of Figure 1. The load cell sensor functions to measure the weight of the infusion bag. To obtain a reading of changes in the volume of liquid 5 ml, a load cell sensor with a capacity of 1 kg is used. To convert analog signals into digital signals, the HX711 converter is used. Data from the sensor will be processed by NodeMCU8266 to determine changes in the weight of the infusion bag. The infusion bag weight display will be displayed on the smartphone via the Blynk application. The mechanical design of the gravimetric infusion can be seen in Figure 2. Numbering 1 in Figure 2 represents the placement of the infusion bag while No. 2 is the panel box of the circuit. The portable infusion pole used in this study has a maximum height of 220 cm. The infusion bag used in this study was 500 ml.

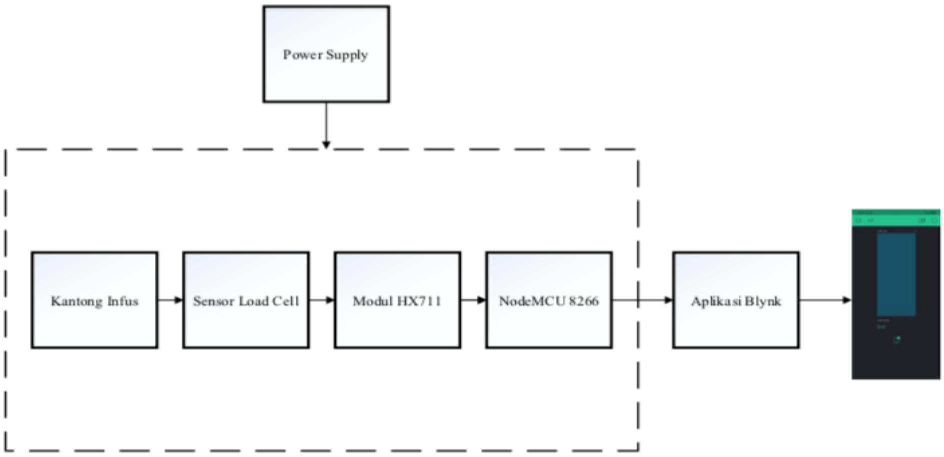

Figure 1. Gravimetric Infusion Block Diagram

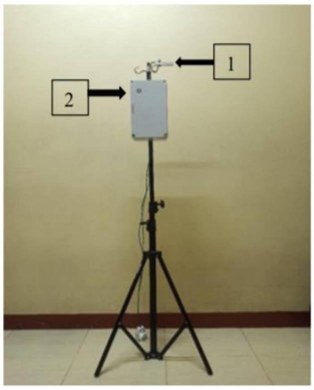

Figure 2. Gravimetric Infusion Mechanic

3. Results And Discussion

Anesthesia is a very important step in surgery. General anesthesia also has a very big risk from surgical procedures because it is related to patient safety, so it is necessary to choose an anesthetic that is truly safe and ideal. Research on anesthetics continues to meet the ideal criteria, namely anesthetics that produce analgesia, relaxation sedation, and produce an unconscious state, are safe for vital systems, and are easy to apply.

3.1. Load cell sensor testing

The load cell sensor is a transducer that works as a conversion of the weight of the object into electricity, this change occurs because there is resistance in the strain gauge. If the load cell has no load then the resistance value is balanced, whereas if it is given a load there will be a change in resistance. This change in resistance will be used to measure the weight of an object. This resistance change will be measured through the voltage value obtained. A load cell is a sensor made of metal foil paper that is formed into fine threads so that it is able to read very small changes in resistance values. This process is used to measure the weight of an object. Changes in the resistance value that will be converted into a voltage can be seen in Table 1. Anesthesia infusion fluid will be measured through a load cell sensor and a digital scale to obtain a valid voltage value. From table 1, it can be seen that there is a greater change in voltage if the amount of infusion fluid given is greater.

Table 1. Sensor Voltage Measurement

Load Cell (ml)	Digital scale (ml)	Voltage (mV)
0	0	0.426
5	5	0.518
15	15	0.562
20	20	0.585
30	31	0.716
40	40	0.756
55	55	0.825
65	65	0.870
75	75	0.916
90	91	0.988
100	100	1.028

To find out small changes in the volume of the infusion bag, a comparison of the readings of the load cell sensor with digital scales was carried out. The comparison of sensor data and digital scales is done repeatedly to produce small errors with high reading accuracy. The volume of infusion fluid used in this study was 500 ml. Figure 3 shows the volume of infusion fluid that has been reduced by 5ml so that the volume in the infusion bag is 495 ml.

Table 2 is the data from the load cell sensor readings with a change of 5 ml. From the table of measurement results, the average error is very small, namely 0.004%, and the high accuracy is 99.8%.

Figure 3. Infusion Bag Fluid Volume Reading

Table 2. Load Cell Sensor Accuracy and Error

Infusion Volume (ml)	Sensor Load Cell (ml)	Digital Scales (ml)	Error (%)	Accuracy (%)
500	0	0	0	100
495	5	5	0	100
485	15	15	0	100
480	20	20	0	100
470	30	31	0.033	98.96
460	40	40	0	100
445	55	55	0	100
435	65	65	0	100
425	75	75	0	100
410	90	91	0.011	98.98
400	100	100	0	100
			Average	0.004

The error generated by the load cell sensor is 0.004%. The error obtained is better than the sensor readings generated in the research conducted by Yanuar with an error of 2.46% [4]. A small error is an important concern because the dose of anesthetic in the intravenous fluid given must be appropriate to prevent the effects of an overdose of anesthetic.

3.2. NodeMCU Testing

The NodeMCU ESP8266 functions to send data on the measurement of fluid weight in the gravimetric anesthetic infusion bag to a smartphone. This is to make it easier to monitor the number of anesthetic doses. The display of the volume of the gravimetric anesthetic infusion fluid on the blynk application can be seen in Figure 4. The amount of fluid in the infusion bag is 405 ml where 95 ml of the anesthetic dose has entered the patient's body.

Figure 4. Gravimetric Anesthesia Monitoring System Display

3.3. Testing the duration of time with the volume of intravenous fluids

This test is carried out to determine the time required for the amount of intravenous fluid that has entered the patient's body. In this study, the time reading was carried out by increasing the volume of anesthetic fluid in the infusion with an increase of 5 ml at a low flow rate. The results of the time measurement for anesthetic fluids can be seen in Table 3.

Table 3. Amount of intravenous fluids against time

Amount of intravenous fluids (mL)	Time (minutes)
5	0.95
15	2.17
20	2.87
30	4.45
40	5.97
55	8.05
65	9.42
75	11.02
90	13.10
100	14.57

The measurement of the number of drops in the infusion fluid and the time required can be seen in Table 3. The test was carried out from 5 ml to 100 ml. The measurement of the number of drops and the time required for 100 ml of 100 ml anesthetic infusion was 1659 for 14.57 minutes. The gravimetric anesthetic dose monitoring system that has been built in this study has resulted in a system that can read the dose of infusion fluid with an error of 0.004% with an accuracy of 99.81%.

Research on the use of intravenous gravimetric anesthesia has been successfully carried out in dogs using a combination of ketamine-propofol at doses of 0.2 and 0.4 mg/kg/minute. This method is an alternative anesthetic method that generally uses inhalation anesthesia [10]. The use of the gravimetric anesthetic method has also been successfully carried out on 12 male pigs using catapults. This study resulted in a safe anesthetic, and did not cause extreme changes in heart rate, respiration, rectal temperature, oxygen saturation, pulse, and CRT values in guinea pigs [11].

This gravimetric anesthesia is a method that has the same results as the inhalation anesthetics commonly used in animals. The advantage of the gravimetric method of anesthesia is that it is a simple and inexpensive system and the advantage is that it can be applied when veterinary surgery is required in the field. Because it does not require a special room and equipment that is complicated and expensive for giving anesthesia.

The number of drops of anesthetic infusion is an important factor to consider besides the dose. Therefore, the ability of this gravimetric anesthetic system will be equipped with drip control of infusion fluids. It aims to obtain the ideal criteria of an anesthetic.

4. Conclusion

The gravimetric anesthetic dose monitoring system with a load cell sensor has been successfully built with an error of 0.004%. The electronic system applied to the gravimetric anesthetic method is able to replace the inhalation anesthetic method which requires complex equipment and high exposure risk. The gravimetric anesthetic dose monitoring system is very helpful for paramedics to perform surgery on animals that must be carried out in the field. To improve the monitoring system for gravimetric infusion anesthesia, an additional system will be added to control the number of drops of gravimetric infusion anesthetic fluid to produce the ideal anesthetic.

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