Development of IoT Based Intravenous Fluid Monitor, Air bubble Detector, Blood back flow Detector, Drop rate Regulator, and Alert System

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ABSTRACT -Close patient monitoring is a big challenge in the existing medical care system. The level of electrolytes is checked manually in our health sector. Inadequate drip system monitoring can lead to complicated issues like fluid backflow, blood loss, irregularity in the fluid droplet, air bubble formation, and other issues. This result from a heavy workload, negligence of health workers, increased number of admitted patients, and more. As a result, it becomes dangerous to patients' health. Incorrect bottle placement could cause patient motility. Irregularity in the fluid droplet can lead to fluid overload or under load, and as a result, causes heart failure, tissue breakdown, pulmonary edema, and many other complications. This system makes use of four sensors to tackle the issues mentioned above. These include a capacitive sensor, air bubble sensor, and load sensor. The air bubble sensor detects the air bubbles in the drip set, and the load sensor checks the minimum level and measures the weight and level of the drip. The capacitive sensor performs two functions: preventing drip droplet irregularities (increment and decrement) and the blood flow back detector. It uses GSM modules with a GSM modem 800L in the device to notify IoT and a dedicated phone number once irregularity is detected.

***Index Terms**:* The Internet of Things (IoT); IV Therapy; Blood flux, Catheter IV fluids, Intravenous (IV) stand or poles

I. INTRODUCTION

The recent report from the Institute of Medicine (IOM) on medical errors conveys two main points. The first is a composed and thoughtful message, urging an understanding of the reasons behind errors in the healthcare system and advocating for the development of computerized and other technical support systems to reduce error rates (McDonald, 2000). Intravenous therapy is used for dehydration, managing fluids and electrolytes, and providing nutrients or for blood transfusions, and it's crucial to helping an individual make a speedy recovery. According to Makar & Daniel (2016), most deaths in health institutions result from errors made by health caregivers. Recently, sophisticated, innovative, high-tech equipment has evolved for patients' speedy recovery and quality health care delivery. Intravenous therapy emerges during middle age. However, several experiments were carried out at first to transfuse blood between human and animal and subsequently from human to human, but it didn't turn out well at the time; the result was rather abysmal, which resulted in putting a stop to the experiment. Although this practice has been around since the 1600s, Due to the lack of knowledge and modern science of the human body, initial attempts to administer drugs and intravenous fluid were unsuccessful Warren (2021). In spite of this hitch, Sir Christopher Wren, who lived from 1632 to 1723, is credited with creating the first successful infusion device during his lifetime. After a long while, apparently, in the 19th century, intravenous infusions were developed which eventually switched to the plastic bag we use today (Medone, 2018) hence the bases of this research. Because fluid resuscitation involves physiological complexity, physicians who prescribe fluid therapy may need a higher level of expertise or a better understanding of its potential to cause harm. The report revealed that inappropriate fluid therapy, while seldom reported, may affect up to 20% of patients. Improper use of fluid management can significantly impact tissue health, potentially leading to adverse outcomes due to inadequate resuscitation or rehydration. As a result, there is an increase in morbidity, longer hospital stays, and even higher mortality rates. (Hoste et al., 2014). Scalp vein occlusions or blockages can occur when a caregiver fails to properly aspirate the blood and flush central lines. Regular aspiration of blood and flushing of central lines is necessary. Catheter occlusions can be either non-thrombotic or thrombotic, with the latter resulting from the adherence of a blood clot to the vessel wall. Approximately 40 to 50 percent of occlusions are non-thrombotic, and they can result from various factors such as catheter malposition, medication precipitates, unfavorable catheter-tip location, or poor-quality dressing used to secure the catheter. As a result, floods flow back to the central line, which is dangerous to the patients (Pharmaplast, 2021).

The steering committee of the 12th Acute Dialysis Quality Initiative (ADQI) conference selected a sample size to conduct research on the optimal fluid management for critically ill patients in the ICU, considering the various factors and considerations mentioned earlier. The committee addressed two questions:

1). Defining the goals of IV fluid administration.

2). Identifying the monitoring of fluid requirements and their effects.

The committee also aimed to identify fluid therapy in various contexts, such as the pre-hospital setting, emergency room, operating theatre, and intensive care unit. These questions served as a starting point for a consensus statement. (Hoste et al., 2014).

Following the work of (Haut et al., 2011), various research efforts have been directed towards developing fluid administration. A study involving 776,734 patients found that nearly half (49.3%) received intravenous fluids before reaching the hospital. In addition, during COVID-19 pandemic, laser fever, and Ebola, healthcare professionals found themselves spread thin among the ever-increasing wave of incoming patients who contracted these highly infectious diseases. Keeping very close monitoring keeps the lives of nurses and doctors at risk, and this has led to the loss of many doctors and nurses during this pandemic. According to the World Health Organization WHO, 115,500 died during the COVID-19 pandemic.

The Internet of Things (IoT) is a commonly used technique to enhance the healthcare system, decrease mortality rates, and alleviate stress. The Internet of Things is a rapidly developing area of technology, society, and economics. Projections regarding the influence of IoT on the internet and the economy are noteworthy, with estimates suggesting the presence of 100 billion IoT devices and a global economic impact of $11 trillion by 2025 (Rose et al., 2015). The Internet of Things (IoT) has garnered significant research interest in recent years. It is seen as an integral part of the future internet and is expected to consist of billions of intelligent communicating devices (Li et al., 2014). IoT is projected to broaden the pervasiveness of the internet by incorporating every object for interaction through embedded systems and other devices (Xia et al., 2012).

A. Statement Of Problem

In a study by (Xu & Zhou, 2006), 208 autopsy cases were reviewed, and twelve cases died at the rate of 5.8% (12/208) during the process of venous infusion. Negligence was the leading cause of this loss. Autopsy showed that the cause of sudden death in 12 cases was related to the venous infusion directly or indirectly. More so when there are large numbers of patients in the ward who receive different types of chemotherapy and several intravenous; the presence of a nurse for each patient is practically impossible and healthcare professionals find it difficult and stressed out to monitor and tend to every patient personally.

Furthermore, errors in medicine are a significant cause of patient morbidity and mortality, often resulting from incorrect volume (either too much or too little) or the wrong type of fluid. In Kano State, Nigeria, a nurse lost her life due to an incorrect route of drug administration. Intravenous fluids and a synchronous-on were initiated post-partum. Shortly after, she experienced a grand mal seizure, leading to cardiac arrest due to ventricular fibrillation, and unfortunately, she could not be resuscitated. Investigations found that a mistake had led to the intravenous administration of 150 ml of a 500 ml bag of 0.1% bupivacaine in saline (Sud & Szawarski, 2017). The lining of the vein can be damaged, leading to the formation of blood clots. This can happen due to repeated use of blunt needles, frequent injection in the same location, or incorrect injection techniques, which can ultimately block and weaken the vein. If left untreated, some damaged veins may not fully recover (American A.C., 2022).

B. Scope of the Study

This study examines the potential of using IoT technology to monitor and control the intravenous administration of patients. This could potentially improve patient care and safety by allowing for real-time monitoring and control of IV administration. The research specifically focuses on patients who require intravenous therapy in order to speed up their recovery. In addition, the well-being of healthcare workers is a key consideration in this study, as they are the ones who will be using the proposed system.

C. Aim and objectives of the study

The objective of this study was to develop an IoT-based system that could monitor and regulate intravenous fluid (IV) drip rates, detect air bubbles, prevent reverse blood flow, and provide alerts to healthcare workers. This system is designed to improve patients' recovery and control abnormalities in IV therapy across the healthcare sector.The objectives include the following:

1) Establish whether there are effects of IV infusion set occlusion (blockage) during administration to patients using hypotheses.

2) To design a system that monitors, detects, creates a base, and signals alarms by applying sensors and IoT technology.

3) Discover whether there is a possibility of death occurrence during IV administration therapy using a chi-square test.

D. Limitations of the Study

It's important to note that the scope of this study is limited to patients in psychiatric hospitals.

This system is not designed to be used on mentally ill patients or mad patients because they could get violent and injure themselves with the device.

E. Research questions

The research questions that guided this study were:

1) What are the effects of IV infusion set blockages during intravenous therapy?

2) How can IV infusion set blockages be detected and prevented?

3) What are the effects of air bubbles in IV infusions on patients' health?

4) What are the effects of reverse blood flow during IV therapy on patients' health?

5) What are the effects of incorrect IV drip rates on patients' health?

6) How can a real-time alert system be designed to monitor and regulate IV therapy?

7) What is the relationship between IV infusion set occlusions and the leading cause of death during IV administration?

8) Will the proposed IoT intravenous monitoring system be effective in healthcare institutions?

II. LITERATURE REVIEW

Sanjay and Vikasin (2020) studied the difficulties patients and nurses face with saline administration. It involves monitoring saline bottles in the hospital. The study uses an amplifier to convert the weight to voltage and a load cell to measure the remaining drip in the saline bottle. Indications, messages, and calls will be made to the nurses on duty.

It's important to note that patients with pre-existing cardio respiratory disease and severe acute illness may be at a higher risk of complications from IV therapy, such as insufficient fluid administration. Signs and symptoms of inadequate circulation and decreased organ perfusion can indicate insufficient fluid administration. This information is from (Hilton et al., 2008), who conducted a study on the risks and complications of IV therapy.

It's important to note that the bioavailability and route of administration of a drug can determine its destination in the body. Bioavailability refers to the amount of the drug that reaches the systemic circulation, while the route of administration is how the drug is delivered to the body (Contributor, 2021). Does this accurately summarize the role of bioavailability and route of administration in drug delivery?

A. Bioavailability

It measures how much a substance can get to the target area, and it depends on how much we get it and secretion (how much we get out). For example, food is taken into your digestive system when you eat. Not all the nutrient molecules will be used; some are excreted, some do not go into the cell, and some are destroyed in the stomach and intestine. Nutrients in the food you eat are absorbed into the bloodstream through the gastrointestinal tract, and some of these nutrients are used or stored by your cells. However, not all of the nutrients you eat are absorbed into the bloodstream, as the body is not 100% efficient. This is according to Ferrer (2021), who conducted research on nutrient absorption and utilization. The bioavailability of a drug is the percentage of the administered drug that reaches the systemic circulation, and the bioavailability achieved by the drug depends on the route of administration. The intravenous route is considered to have 100% bioavailability, as shown in the graph below (Choudhary, 2021).

Bioavailability of drugs

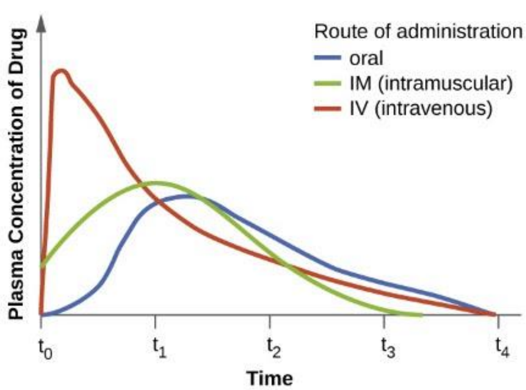


Fig 1: Bioavailability of drugs(Source: Choudhary, 2022)

B. Drugs administrative routes

A safe and appropriate route should be followed to administer a vaccine. However, many factors can impact the reactogenicity and tolerability of a given vaccine, such as depth of injection and injection technique, body size and mass, needle length, vaccine formulation, age, sex, adjuvant, and Kasinathan (2017).

There are many routes to administer drugs to the body to obtain a maximum therapeutic effect. Yes, the different routes of drug administration include parenteral (injection), oral, and topical (skin). It's true that some drugs may be more effective when administered by injection rather than orally, as they may not be absorbed effectively by the gastrointestinal tract. This is why some drugs are given through injection or topical application, as these routes may be more effective for the specific drug. Yes, the bioavailability of a drug may differ depending on the route of administration. Intravenous administration of a drug allows it to be fully absorbed into the systemic circulation, giving it a bioavailability of 100% (Kasinathan, 2017). However, the oral route of drug administration may have a much lower bioavailability, as the drug must pass through the gastrointestinal tract and be absorbed by the body. The Nursing Times article mentions the five major routes of drug administration. For the purpose of this discussion, we'll focus on the parenteral route. This route of administration involves injecting the drug into the body. It includes the intravenous, intramuscular, and subcutaneous routes.

C. Parenteral administrative routes

In summary, parenteral drug administration refers to any route of administration that does not involve the gastrointestinal tract. This includes injection directly into the bloodstream (intravenous), into a muscle (intramuscular), beneath the skin (subcutaneous), or around the spinal cord. These routes bypass the digestive system and allow drugs to be absorbed directly into the body. In addition to what we've already discussed, there are four main types of parenteral injection routes: intravenous (IV), subcutaneous (SC), intramuscular (IM), and intrathecal (IT). The intravenous route involves injection directly into a vein, while the subcutaneous route involves injection just beneath the skin. The intramuscular route involves injection into a muscle, and the intrathecal route involves injection around the spinal cord. Each route has its own advantages and disadvantages, and the choice of route depends on the drug being administered. Le Jennifer (2020).

D. Intramuscular:

A drug that is administered via the intramuscular route is absorbed rapidly into the bloodstream, due to the high vascularity of muscle tissue. This rapid absorption and distribution results in high bioavailability, with a large proportion of the drug reaching its target site.

(Dougherty *etal*, 2008). This is preferable to the subcutaneous when a larger volume of drug is required for a patient. The intramuscular route is suitable for drugs that are not well absorbed through the skin or fatty tissue. This is because muscle tissue is located beneath the skin and subcutaneous fat, requiring a longer needle to reach the target site. There are several potential complications associated with intramuscular injections if they are not performed correctly. These include abscesses, nerve damage, blood vessel damage, muscle scarring, pain, and bleeding. To reduce the risk of needle-stick injuries, safety needles with retractable sheaths should be used. These needles are designed to protect the user from accidental needle sticks.

E. SUBCUTANEOUS

Following the work of Lee Jennifer (2020), The subcutaneous tissue, composed primarily of fat cells and connective tissue, is the innermost layer of the skin. A needle is injected into the layer of fat just under the skin for subcutaneous administration. Following intramuscular injection, the drug is absorbed into the capillary network of the muscle tissue, where it enters the systemic circulation and is transported to target sites throughout the body.

F. Intrathecal

To deliver drugs via intrathecal administration, the drug is injected into the spinal canal or subarachnoid space, allowing it to access the cerebrospinal fluid (CSF). This route is commonly used in spinal anesthesia, chemotherapy, and pain management.

G. Intravenous

To administer drugs via intravenous (IV) injection, the drug is directly injected into a vein, allowing for rapid absorption into the bloodstream. In addition to being fast-acting, IV administration is relatively convenient, as a single catheter or cannula can be used to deliver multiple doses of medication over a period of time. In contrast to other routes of administration, there is no need to repeatedly insert a needle**.** (Johnson, 2021).

IV injection application

Fig 2: IV injection application (Source: Advance Staff, 2022)

H. Review of Previous Work in IoT Intravenous

According to Tanwar *et al.* (2021), an IoT-based control platform for IV infusion setup was developed to streamline monitoring and reduce the risk of error. This platform offers wireless monitoring capabilities and allows for real-time detection of any abnormalities in the IV infusion setup. Improper administration of IV drips can have serious consequences, so this platform is designed to ensure accuracy and minimize the potential for errors.. This proposed system delivers a comprehensive package that integrates all these lapses into one system.

Finally, Prabha *et al.* (2021) stated that the health monitoring system is one of the most critical vital issues concerning medical facilities. This issue includes monitoring the saline flow rate, pulse rate, and temperature rate. They used an IoT method to solve some of the problems, and data can be segregated based on the type of disease the patient has and then stored in the Google database. An infrared sensor monitors fluid levels through heart readings and temperature rates. However, the limitation of this system is that it does not regulate the drip flow rate or detect bubble formation.

III. Software Development Methodology

This research was carried out with research questions, SPSS, triangulation methodology (qualitative and quantitative approach), UML modeling tools, and (RAD) agile software development methodology. In the field of software development, RAD (Rapid Application Development) is a model that emphasizes rapid prototyping, iterative development, and continuous feedback from users. This model is flexible and adaptable, allowing for changes and adjustments to be made quickly and easily throughout the development process. IoT technology, and a Hypothesis Test using the chi-squared method.

A. Modeling tools used:

1). Use case diagram

A use case diagram depicts the system's dynamic behavior, illustrating the actors and their relationships with use cases.

Fig 3: Use Case Diagram

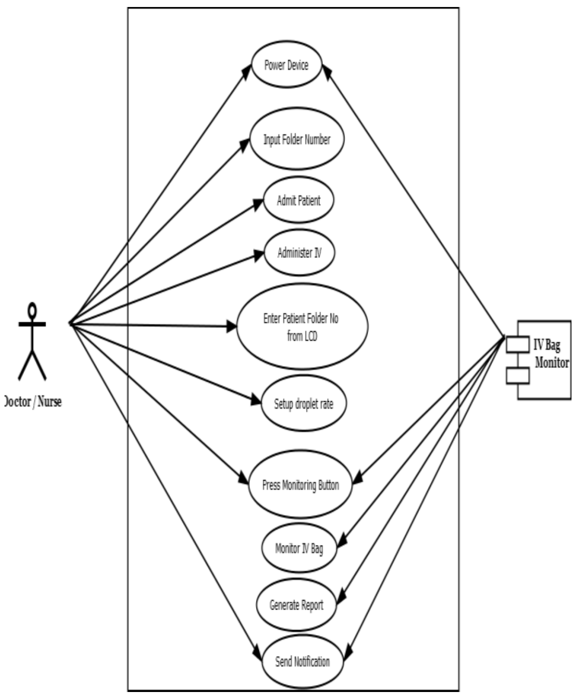


Fig 3: Use Case Diagram

Fig 3 is one of the methodologies used to analyze the Intravenous system to clarify, identify, and organize system requirements.

2) Sequence Diagram

Fig 8 is an interaction diagram that depicts the interactive behavior of an IoT monitoring system. Interactions in a system can be complex, so we use interaction diagrams to capture different aspects.

Fig 4: Sequence Diagram

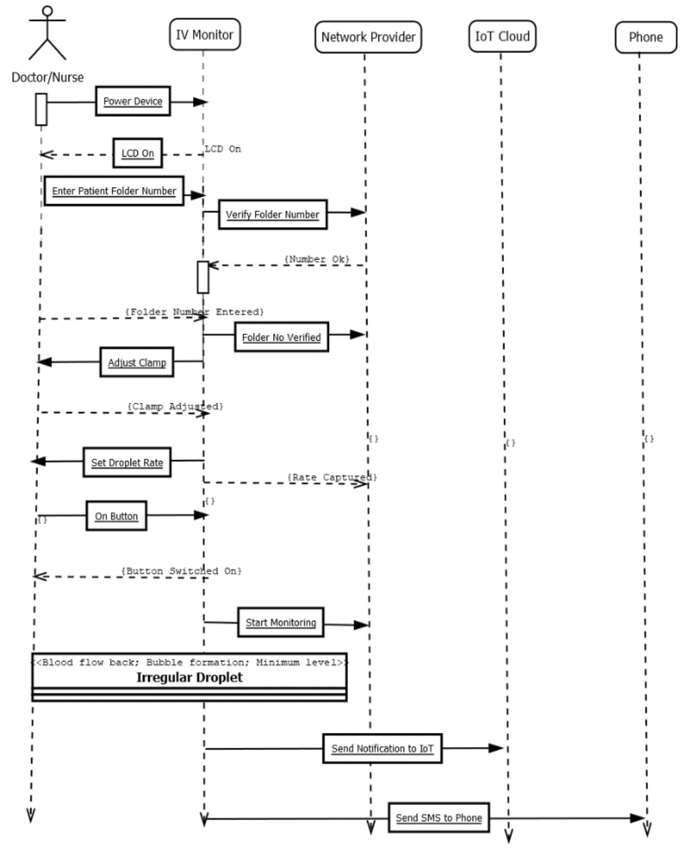


Fig 4: Sequence Diagram

3). Entity Relationship Diagram

Figure 5 illustrates how "entities (admin, nurse and patients) relate to each order in the system.It depict the interconnectedness of entities, relationships and their attributes and also used to model and design IoT databases

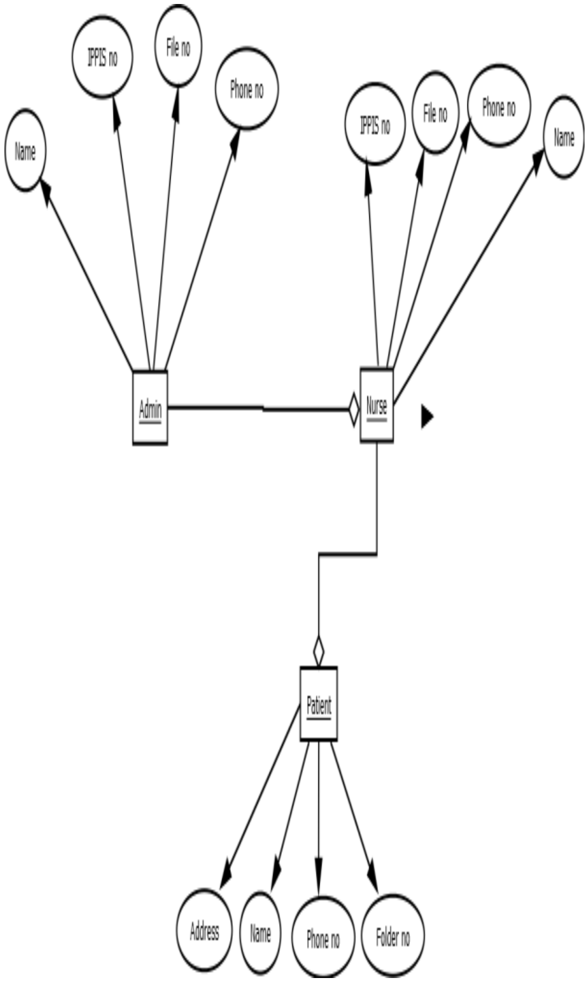


Fig 5: Entity Relationship Diagram

4). Flow Chart Diagram

A flowchart is a diagram that depicts a process, system, or computer algorithm. It is used when better communication is needed between people involved in the same process.

Figure 3, 4 and 5 illustrate the monitoring of minimum level, blood flow back and air bubble respectively

Fig 6: Droplet Flowchart

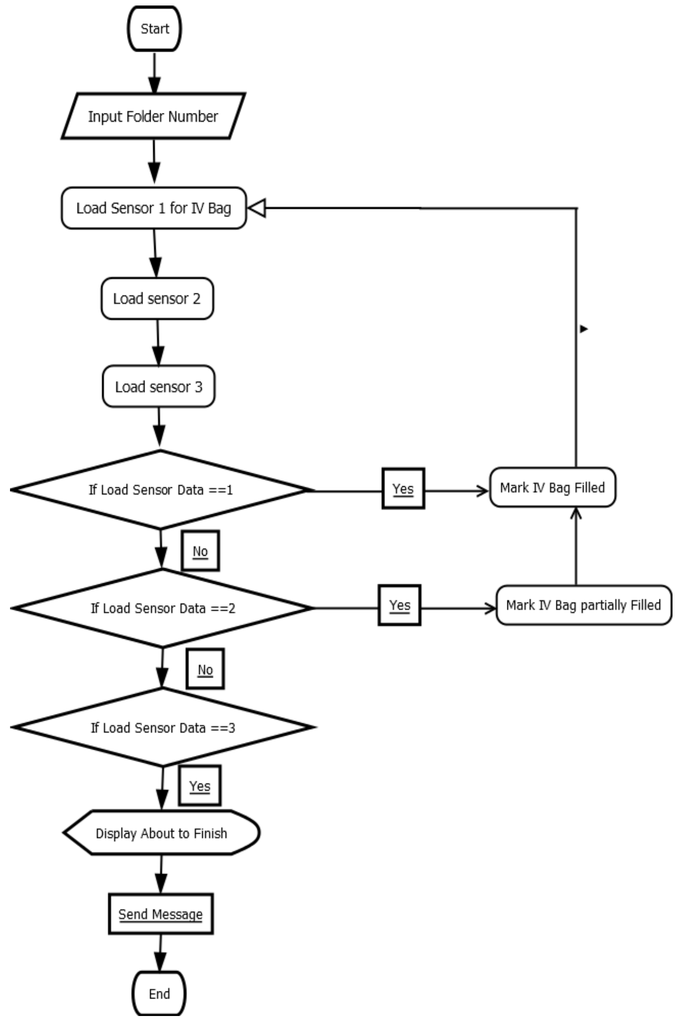


Fig 6: Droplet Flowchart

5) Fig 7: Blood Flux Flowchart

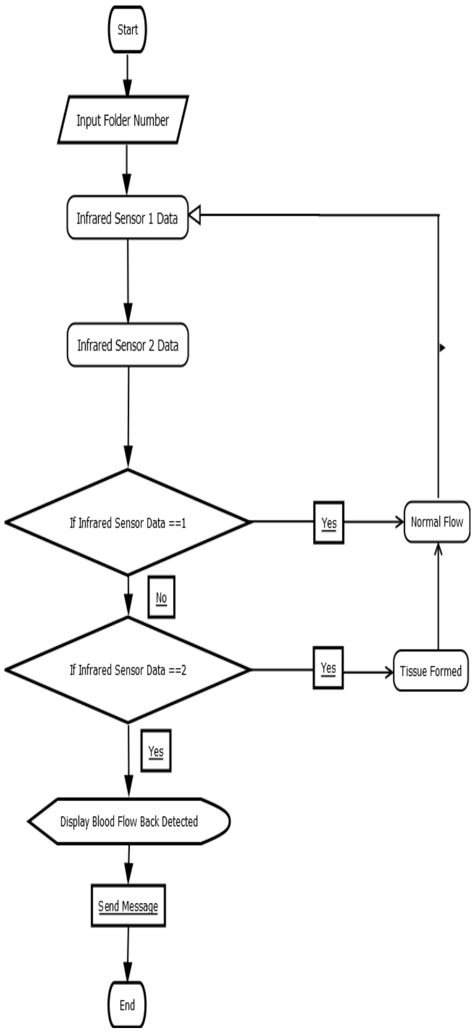


Fig 7: Blood Flux Flowchart

Figure 8: Air bubble

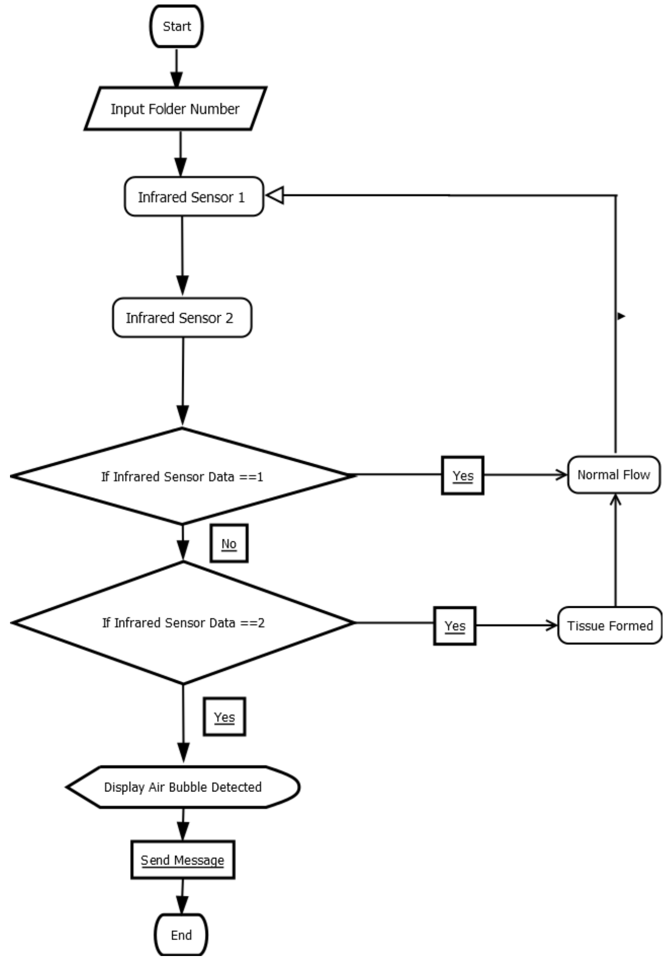


Figure 8: Air bubble

B. Functional requirement

1) Folder Number: The primary input requirement of this system is the folder number, which the system uses to identify each patient for proper performance and documentation.

2) Bubbles detection: The infrared sensor should be able to detect air bubbles in the IV line whenever there is a blockage.

3) Minimum level detection: The IV Infusion bottle's fluid level is detected using a load sensor to 5ml and transmits the data to the IoT

4) Blood flux detection: When there is blood flow back, Infrared technology should be able to detect it.

5)Internet connection: This is a functional requirement on the software part to enable it to send notifications as required

6) View database: The admin should be able to view the database to ascertain daily reports.
7) Create different file formats: After viewing the report, he should be able to export the files into a desired format, such as Excel, Microsoft Word, or PDF format for reference purposes.

C. Nonfunctional Requirement

1) The system should be flexible. It is monitoring several IVs not tailored to one. This means that any intravenous fluid could work perfectly well with the system.
2) The system should handle several patient reports: It should be able to document and store enormous amounts of data for reference purposes.
3) The system should be user-friendly: The system should be easy to operate, learn, and use with little or no supervision.
4) No Internet connection. On the part of the device, it works even without the internet, only that it cannot send notifications on the required end.
5) Multitasking. The ability to multitask is an important benefit of this system, as it allows a single individual to monitor and manage multiple patients at the same time. This can improve efficiency and help reduce costs for healthcare facilities.

D. Block diagram

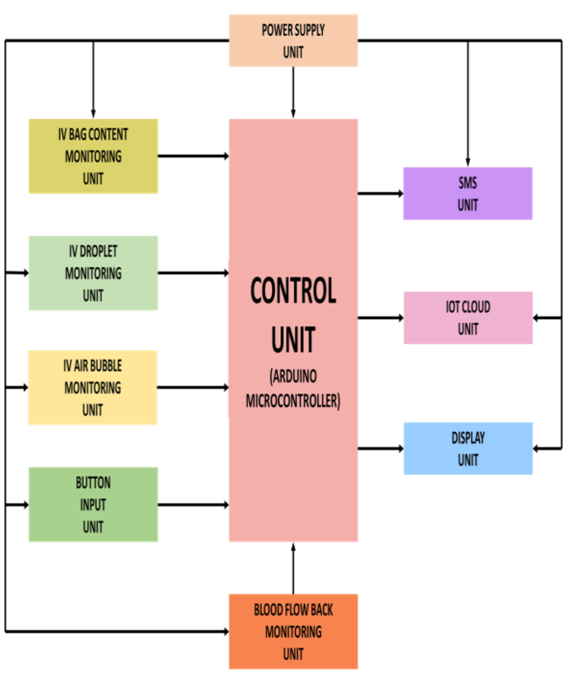


Fig 9: Block diagram for Saline level Monitoring and Automatic Alert System

Fig 9 is the diagram of the new system showing in schematic form the general arrangement of the parts or components of this robust system or process, such as the control unit, and the circuit flow of other unit associated in the integration of the system.

E. Demographic data of the respondents

Table 1: Intravenous (Drip) Monitory Stage

S/N	**Question**	**Item**	**Responses**	**Percentage**
1	Where the nurses coming regularly to check on you and the status of the drip	Yes	24	10.6
		No	203	89.4
		Total	**227**	**100**
2	If yes how often	10 munities	18	7.9
		20 munities	62	27.4
		1hr	147	64.8
		Total	**227**	**100**
3	Have you ever observed a blockage while taking a drip	Yes	186	81.9
		No	41	18.1
		Total	**227**	**100**
4	Have you noticed air bubble on the drip line before	Yes	182	80.2
		No	45	19.8
		Total	**227**	**100**
5	Have you noticed blood flowing back through the IV line	Yes	189	83.3
		No	38	16.7
		Total	**227**	**100**
6	Have you noticed irregularity in the flow rate (either being too fast or being too	Yes	168	74
		No	40	30.4
		Undecided	19	8.4
		Total	**227**	**100**

	slow)			
7	Have you hard an absence before	Yes	129	56.8
		No	68	30
		Undecided	30	13.2
		Total	**227**	**100**
8	Are there effect of IV infusion set occlusion (blockages) during IV therapy	Yes	164	72.2
		No	51	22.5
		Undecided	12	5.3
		Total	227	100
9	Had there being a time any of these stated above happened without the presence of a nurse or doctor	Yes	167	73.6
		No	33	14.5
		Undecided	27	11.9
		Total	**227**	**100**
10	Effect of IV infusion set blockages during IV therapy	Yes	164	72.2
		No	51	22.5
		Undecided	12	5.3
		Total	**227**	**100**
11	Have the Institution ever recorded any death as a result of any of the abnormalities	Yes	121	75.2
		No	18	11.18
		Undecided	22	13.66
		Total	**161**	**100**

F. Hypothesis Test 1

There are two hypotheses concerning the impact of IV infusion set blockages during intravenous therapy.

H0 states that there is no significant negative effect, while

H1 states that there is a significant negative effect. The statistical tool used to test these hypotheses was the chi-square, which was applied to a contingency table that had been previously calculated using simple percentages. The formula for calculating the chi-square value was also used.

$$\chi 2 = \sum_{r}\sum_{c}\frac{\left(O_{r,c} - E_{r,c}\right)^2}{E_{r,c}}$$

Where x^2 = chi-square

∑= summation

o= observed frequency

E= expected frequency

R = number of row

C = number of Colum

Items 3, 4, 5, 6, 7, and 8 are used to test this hypothesis.

Table 2: Hypothesis 1(Chi squared test)

Items no	Responses			χ^2	P-value
	Yes	No	Undecided		
3	186(81.9%)	41(18.1%)	0 (0.0%)	108.488*	<0.001
4	182(80.2%)	45(19.8%)	0 (0.0%)		
5	189(83.3%)	38(16.7%)	0 (0.0%)		
7	129(56.8%)	68(30.0%)	30(13.2%)		
8	164(72.2%)	51(22.5%)	12 (5.3%)		

*Fisher's exact test used Researchers field work

The hypothesis is rejected (P<0.05) and concludes that IV infusion set blockages have a significant adverse effect during intravenous therapy. This implies that most of the respondents 189(83.3%) assured blood flow back through the IV line (item 10), while those that indicated they had not had an absence before were the least (30.0%) in item 12

G. Hypothesis Test 2

H0: There is no significant possible death occurrence among patients under intravenous therapy in health institutions

H1: There is a significant possibility of death in patients under intravenous therapy in health institutions

Items number 10 and 11 are used to test this hypothesis

Table 3: Hypothesis 2(Chi squared test)

Items no	Responses			χ^2	P-value
	Yes	No	Undecided		
10	164(72.0%)	36(22.4%)	9 (5.6%)	11.557	0.003
11	121(75.2%)	18(11.2%)	22(13.7%)		

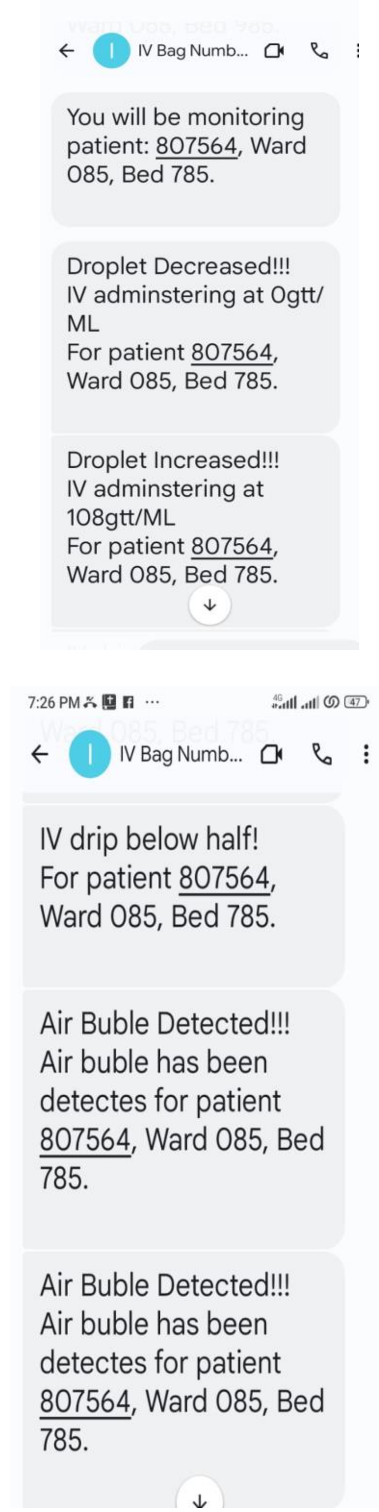
Hypothesis is rejected (P<0.05) and therefore conclude that there is significant possibility of death occurrence towards patients under intravenous therapy in health institutions. This implies that greater percentage of the respondents (75.2%) indicated that: Institution have recorded death as a result of the abnormalities.

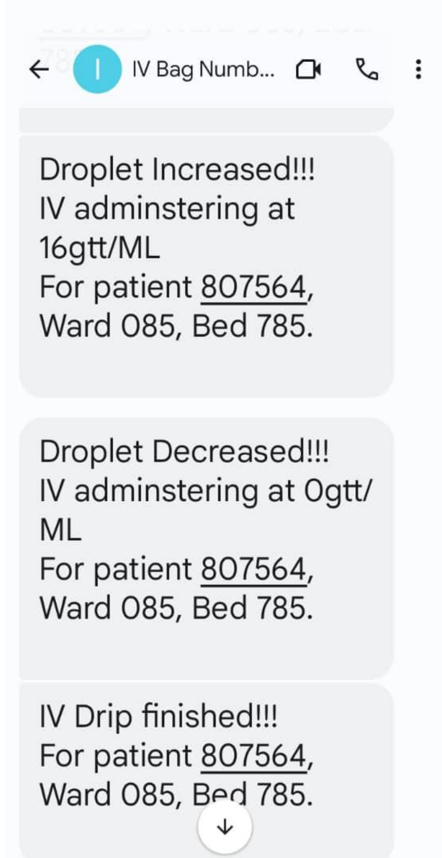
IV. SYSTEM IMPLEMENTATION

To implement the system, a reliable network was set up to access the IoT platform. Then, a device such as a laptop or Smartphone was used to connect to the system. This ensured that all the complex systems were well-coordinated and ready to support the new system.

V. Output Result

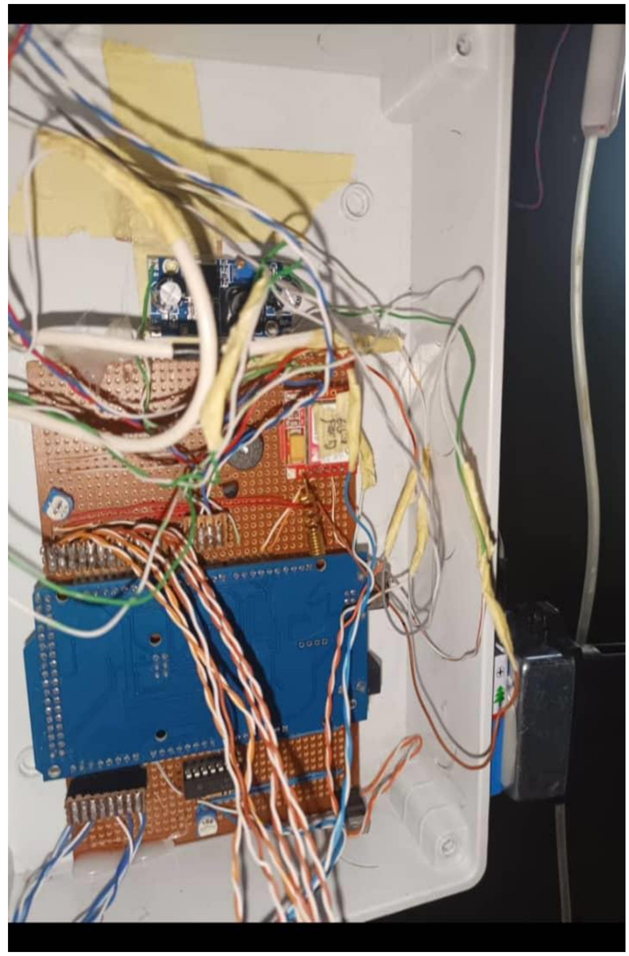
Figure 10: SMS Alerts notification





SMS Alerts notification

Figure 11: IoT Based Intravenous Fluid Monitor Vero board and connectors



IoT Based Intravenous Fluid Monitor Vero board and connectors

Figure 12: IoT Based Intravenous Fluid Monitor, Air bubble Detector, Blood back flow Detector, Drop rate Regulator, and Alert System

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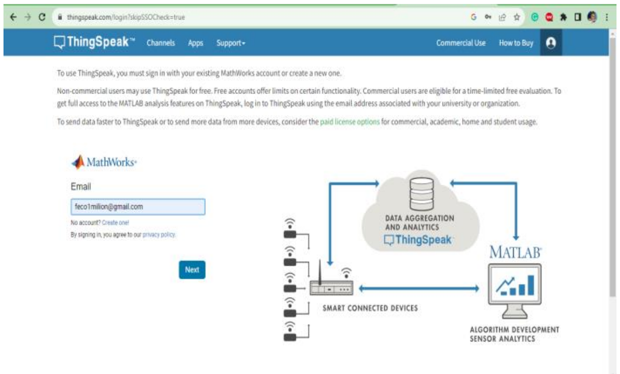
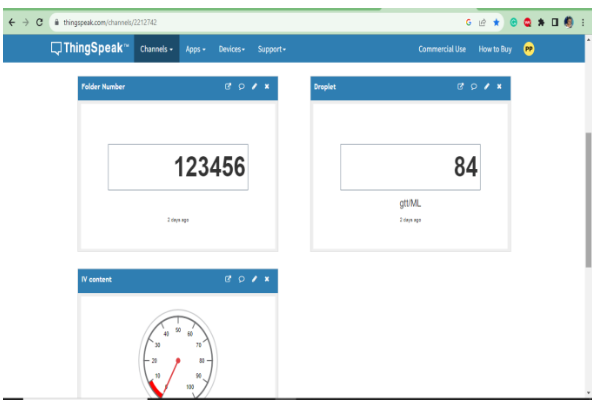
IoT Based Intravenous Fluid Monitor, Air bubble Detector, Blood back flow Detector, Drop rate Regulator, and Alert System

Fig 13: Thing Speak login Panel



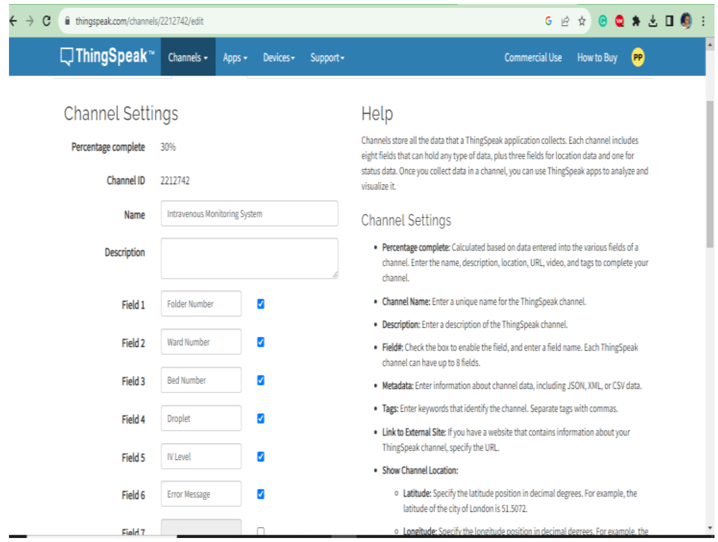
ThingSpeak Login Interface

Fig 14: Real time display channel



Real time display channel

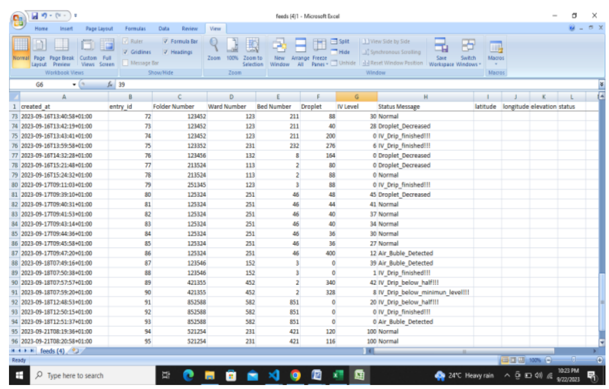
Fig 15: Field Description



Field description

A. Database implementation

Fig 16: Database implementation



Database implementation

B. Hardware Requirement

Arduino Microcontroller, Sensors, Buzzer, Smartphone, ATmega328 chip, Power supply unit, LCD, Drip stand, IV Bag, Drip set, Connectors, Roller clam, Vero board, GSM modem Sims 800L, Arduino Mega.

VI. CONCLUSION

Ineffective IV monitoring systems are due to the need for standardized development-based intravenous monitoring systems in healthcare institutions. This has impacted healthcare organizations whose current system cannot address these issues. In conclusion, adopting the newly designed enhanced intravenous monitoring system will improve healthcare delivery and overcome the flaws observed in the existing systems. This research successfully developed an IoT Intravenous Monitoring System to achieve the following objectives: designing a system that monitors, detects, creates a database, and signals alarms using sensors and IoT technology to establish the effects of IV infusion set occlusion and evaluating the effectiveness of the new IoT-based intravenous monitoring and alert system in healthcare institutions.

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