Design of Blood Reversal Prevention in IV Therapy

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Abstract: - A novel approach to prevent blood reversal in IV therapy by utilizing a load cell and Arduino-based system. The proposed system consists of a load cell integrated into the IV line, which continuously monitors the pressure changes within the line. When the pressure exceeds predefined thresholds, suggesting potential blood reversal, the Arduino microcontroller triggers an alarm, notifying the medical staff and halting the infusion. The load cell's sensitive and real-time monitoring capabilities offer a reliable means to detect changes in fluid dynamics within the IV line accurately. The Arduino microcontroller acts as the control unit, analyzing the data from the load cell and taking immediate action to prevent any blood reversal incidents. Additionally, the system can be easily integrated into existing IV setups, making it a practical and cost-effective solution for healthcare facilities. Through rigorous testing and validation, the proposed load cell and Arduino-based system demonstrate promising results in preventing blood reversal incidents during IV therapy. This innovative technology has the potential to enhance patient safety, reduce medical errors, and improve the overall quality of care during IV administration.

Keywords: Intravenous (IV), Arduino, healthcare, therapy .

Introduction

Intravenous (IV) therapy is administering fluids directly into a vein.it benefits treatment by enabling water ,medication, blood ,or nutrients to access body faster through the circulatory system.IV therapy is the most common invasive procedure medical professionals use in health care field. This novel technique to managing the danger of blood reversal in intravenous (IV) therapy provides a paradigm-shifting approach. This method can precisely monitor changes in the weight of the fluid container by cleverly inserting a load cell into the IV setup. This allows for continuous and accurate fluid dynamics monitoring. This extensive understanding includes monitoring fluctuations in flow rates and pressure shifts along the entire IV line. The Arduino Nano microcontroller, which acts as the system's brain and serves as the central command centre, is at its core. Bluetooth technology is used for communication, ensuring real-time data transmission and prompt alarms. This break from traditional internet-dependent methodologies makes the system incredibly flexible and adaptive across a broad range of healthcare situations. Notably, its extensive usage of Bluetooth considerably reduces the time and effort required for setup, easing the administrative strain on medical staff and allowing for smooth integration of this technology into current healthcare processes. The system's dynamic synergy between the load cell, Arduino Nano, and Bluetooth capabilities gives it the unique ability to actively monitor IV fluid dynamics. Instantaneously detecting deviations from predetermined parameters allows it to take quick corrective measures using the Arduino microcontroller, such as brief halts in the infusion of medication and alarm alerts. In turn, patient safety is improved as a result of this proactive approach's crucial role in reducing the likelihood of medical errors. The system's capacity to adapt to various IV setups is an additional noteworthy characteristic that confirms its applicability and affordability in a variety of healthcare settings, including busy hospitals, far-flung clinics, and even home-based care. The enormous potential of this load cell and Arduino-based system has been highlighted by painstaking validation procedures and rigorous testing. Its use by medical practitioners is a positive development that not only improves the IV administration process' quality but also dramatically lowers the frequency of blood reversal occurrences. A new era of safety and effectiveness in IV therapy is being ushered in by this pioneering strategy, which represents a critical step towards enhancing patient well-being and enhancing the dependability of critical medical interventions.

Main Text

Survey Of Literature

K.N Baluprithviraj Et al, proposed an IoT-based system that use a load cell to gauge

the level of the saline bottle and a solenoid valve in order to stop the opposite flow of blood. The system also monitors the condition of the patient body temperature, oxygen saturation, and pulse rate using sensors and displays the data on a mobile app using Blynk platform. The paper presents the hardware and software design, as well as the experimental results within the system. The writers suggest A framework that uses a sensor for weight to convert the saline bottle's weight into voltage signals and an Arduino Uno to process the data. The system also uses a buzzer and an Liquid Crystal Display to indicate the saline bottle's level and sends the data to a web server using ESP8266 Wi-Fi module. The paper discusses the advantages, disadvantages, and future scope of the system.

S Barath Sanjay Et al, proposed a prototype of Smart IV Drip Stand that employs a

load cell to determine the level of the IV fluid and a solenoid valve to prevent the blood's opposite flow. The prototype also uses a keypad and a servomotor to adjust the flow rate manually or automatically. The paper presents the both software and hardware design, as well as the experimental results of the prototype. This article describes a system that uses LED photodiode pairs to determine the degree of the IV fluid additionally a servo motor to clamp the IV line. The system also alerts the nurses and doctors through app and an indicator LED.

The article explains the working principle, circuit diagram, and code of the system.

J. Sanjay Raju et al. suggested a system that makes use of an inert liquid level indicator that detects the existence of blood in the IV line and sends a signal to a microprocessor that controls the servomotor. The servomotor then activates a locking gadget that clamps the IV line and stops the blood's opposite flow. system is easy additionally affordable to implement and does not interfere with the normal flow of fluids or medications in the IV line. The system also has a manual override switch that allows the health care staff to unlock the gadget in case of emergency. The paper presents the hardware and software design, as well as the static and flow analysis of the system using ANSYS software. The system described in this paper uses a a storage cylinder, an automated flow limiting valve, and a specially made unidirectional valve to prevent the reverse flow of blood in IV therapy. The apparatus makes use of a load cell to gauge the degree of the IV fluid and a solenoid valve to prevent the reverse flow of blood. The system also uses a keypad and a servomotor to adjust the flow rate manually or automatically. The paper provides the static evaluation of the unidirectional valve and cylinder, as well as the glucose flow analysis via the unidirectional valve and blood stoppage during the reverse flow using mathematical calculation and simulation.

Rajasekar Rathanasamy Et al, proposes a smart device to regulate the blood flow from the intravenous line in reverse. The apparatus makes use of a storage cylinder, an automated flow limiting valve, and a specially made unidirectional valve to prevent the blood's opposite flow. The paper presents the static analysis of the cylinder and the unidirectional valve, as well as the glucose flow analysis via the unidirectional valve and blood stoppage during the reverse flow using mathematical calculation and simulation.The paper aims to solve the problem of the blood's reverse flow during intravenous therapy, which can cause serious complications for patients who need glucose drips or dextrose. The paper claims that the conventional method of changing the glucose bottle after it has been used up. is inefficient and calls for an experienced observer. The paper also claims that the existing methods of preventing or detecting the reverse flow of blood are costly, complex, unreliable, inaccurate, or unavailable. The paper introduces the design and working principle of the smart device, which is made up of four primary parts: a load cell, a solenoid valve, a servomotor, and a storage cylinder. The load cell gauges the level of the glucose bottle as well as sends a signal to a microprocessor. The solenoid valve prevents the reverse flow of blood by closing when the load cell detects an empty bottle. The servomotor adjusts the flow rate of glucose manually or automatically using a keypad. The storage cylinder stores excess glucose when the flow rate is higher than required.

Janaki Moorthy Et al, proposed a smart device to regulate the intravenous line's blood flow in reverse. The apparatus makes use of a storage cylinder, an automated flow limiting valve, and a specially made unidirectional valve to prevent the blood's opposite flow. The paper presents the static analysis of the cylinder and the unidirectional valve, as well as the glucose flow analysis via the unidirectional valve and blood stoppage during the reverse flow using mathematical calculation and simulation.

"Central Venous Catheters: A Review of Types, Complications, and Management" (Karen E. Johnson, Critical Care Nurse, 2019, 39(2), 45-53):This paper likely provides a comprehensive review of central venous catheters (CVCs).It may discuss different types of CVCs, their applications, and potential complications associated with their use.The focus might also include strategies and management approaches for minimizing complications related to central venous catheterization

"Pediatric Intravenous Therapy: Challenges and Considerations" (Robert L. Anderson, Pediatric Nursing, 2020, 46(3), 145-152):This paper is likely to address the unique challenges and considerations involved in pediatric intravenous therapy.It may discuss age-specific factors affecting the administration of intravenous treatments in children.The article may also cover best practices and recommendations for ensuring the safety and effectiveness of IV therapy in pediatric patients.

3. Implementation

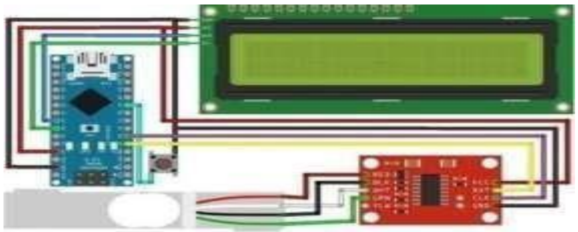

Figure 3 Circuit diagram of blood reversal prevention system in IV therapy

Figure 4 Working model of blood reversal prevention in IV therapy when buzzer is OFF

An Arduino Nano, and a Bluetooth module is the blood reversal prevention system in IV therapy(Fig 3). This integrated system tries to stop the backflow of blood. When the liquid level sensor determines that the IV bag is empty, the system's servomotor-controlled locking device blocks the IV tube. To facilitate the processing the data obtained from the load cell and sensor, which determines the IV bag's weight, the system additionally employs a microprocessor. In order to process the information from the sensor and the load cell, which determines the IV bag's weight, the system additionally employs a microprocessor. The technology may connect through Bluetooth to a smartphone app, enabling healthcare professionals to monitor and manage the transfusion process in actual time. When the IV bag must be changed or when there is any irregularity in the transfusion process, the app can alarm and notify the clinicians and preserve the data for later study and storage(Fig 4).

4.**Result And Discussion**

Figure 5 Saline water level and buzzer through Bluetooth

The Blood reversal prevention system in IV therapy using a load cell, Arduino Nano, and Bluetooth offers a comprehensive solution for monitoring and controlling blood reversal processes, enhancing patient safety, and streamlining healthcare processes. Key features include load cell measurement, Arduino Nano control, Bluetooth connectivity, data logging, alarms and alerts, user-friendly interfaces, and remote control capabilities. The benefits include improved patient safety, real-time monitoring, data analysis for process improvement, reduced manual intervention, enhanced documentation, cost-effectiveness, and peace of mind for patients and their families. Overall, such a system represents a valuable tool for healthcare providers in ensuring the safe and accurate administration of blood reversal processes.

5.**Conclusions**

A number of features and advantages of the blood reversal prevention system used in IV therapy improve patient safety and healthcare administration. The system can avoid blood loss and lower the danger of problems and unfavorable reactions that might result from reverse blood flow, such as hemolysis, clotting, air embolism, and infection, by continuously monitoring the blood reversal processes. Healthcare professionals may remotely monitor and control the transfusion process from their cellphones thanks to the system's user-friendly interface and wireless connectivity, which gives them flexibility and peace of mind. Additionally, because the device automatically stops the reverse flow of blood and notifies the physicians when necessary, it minimizes manual intervention and human mistake. The technology also improves documentation and accountability since it captures and records information about the transfusion process, including the volume of fluid administered, how long it took, and any mishaps or mistakes. The system is also affordable because it makes use of inexpensive and easily accessible parts including an Arduino Nano, a load cell, a servomotor, and a liquid level sensor.

6.List Of Abbrevations

1. IV – Intravenous Therapy
2. LED – Light Emitting Diode
3. ANSYS - Analysis System
4. IOT – Internet of Things
5. LCD – Liquid Crystal Display
6. CVC - Central Venous Catheters

7.Declaration

Availability Of Data And Materials:

All data generated or analysed during this study are included in this published article [and its supplementary information files].

Competing Interests:

The authors declare that they have no competing interests.

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Authors' Contributions:

RL contributed on interfacing load cell with Arduino and created Bluetooth app. SS contributed on hardware works and verification on load cell. TK contributed on supporting others and interfaced Arduino with alarm. All authors read and approved the final manuscript.

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Not applicable

8.References

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