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SMART Intravenous Infusion Dosing System

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ABSTRACT

With intravenous (IV) infusion therapy, the patient's vein can be used to administer the infusion fluid. It is used for blood transfusions or to administer drugs directly into the bloodstream. A hospitalized patient has a 60–80% chance of receiving intravenously administered infusion treatment. The describes a smart IV infusion dosage system for remote liquid in an IV bottle detection, signaling, and monitoring. It consists of three layers: sensing and computation (an IV fluid level detection and signaling system, and a system for controlling and stopping infusion flow); communication (a wireless information transfer between the hardware component of the system and the client); and user (monitoring and visualization of IV therapy).real-time reception at a distant place. Because each layer is modular, the entire system can be upgraded. The proposed system notifies medical staff when IV bottles need to be continuously and promptly changed, which can improve the success of IV therapy, particularly in oncology patients. For the cytostatics to work as intended, the IV chemotherapy drip time should be strictly adhered to.

Keywords : Internet of Things (IoT), wireless intravenous system, intelligent IV infusion dosage system, IV therapy, IV bottle, IV chemotherapy, nurse response time, and remote infusion monitoring system

I. INTRODUCTION

A needle or cannula is used to inject fluid directly into a patient's vein during intravenous infusion therapy, a common medical practice used in all areas of medicine. Particularly during surgical and postsurgical operations, IV infusion treatment is utilized to administer medications directly into the patient's bloodstream and to transfuse blood or some of its constituent parts. Additionally, it is applied to patients who have digestive system issues, those who are dehydrated, those who need to correct electrolyte imbalances, those who are cancer patients, and, more and more frequently nowadays, those who have coronavirus disease 2019 (COVID-19). Therefore, there is a 60–80% chance that a hospitalized patient may undergo intravenous infusion therapy of some kind.

Although IV infusions are mostly uneventful, they can occasionally be excruciatingly painful, especially for oncology patients receiving cytostatics. Even while not all cytostatic are as severe, a few months of intravenous cytostatic therapy causes serious, irreversible damage to the veins. These veins "withdraw" and are consequently challenging to locate during the following therapy session since they significantly diminish their tone in addition to changing color and darkening.A nightmare and significant psychological issue for almost all cancer patients, there eventually comes a moment where there are no longer any veins on the patient's hands that can endure dailycytostatic therapy after multiple cycles of IV chemotherapy. For instance, the cisplatin/etoposide/bleomycin (PEB) and cisplatin/etoposide/ifosfamide (PEI) protocols are employed in the treatment of patients with testicular cancer of the seminoma- and non-seminoma-type, respectively.

In order to give IV chemotherapy, IV bottles must be changed continuously and promptly, necessitating constant staff observation and prompt action. The attendance of a nurse for every patient, however, becomes practically impractical when there are several patients receiving multiple IV bottles of different forms of chemotherapy per day. Keep in mind that if the IV bottle is not changed promptly, the blood frequently returns to the infusion line and blocks the cannula.This procedure frequently requires multiple attempts because the patient's veins are already damaged to an advanced degree, resulting in bruising.

II. LITERATURE SURVEY

Modern healthcare must include a Smart Intravenous Infusion Dosing System (SIIDS) in order to increase patient safety and therapeutic effectiveness. The main advancements and trends in SIIDS over the previous several years are examined in this literature survey. Recent developments in SIIDS concentrate on improving automation and precision. Real-time monitoring and integration with electronic health records have grown in popularity, enabling prompt medication adjustments and lowering human error rates. Additionally, the integration of AI and machine learning algorithms in SIIDS has demonstrated potential in anticipating patient demands and enhancing drug administration.

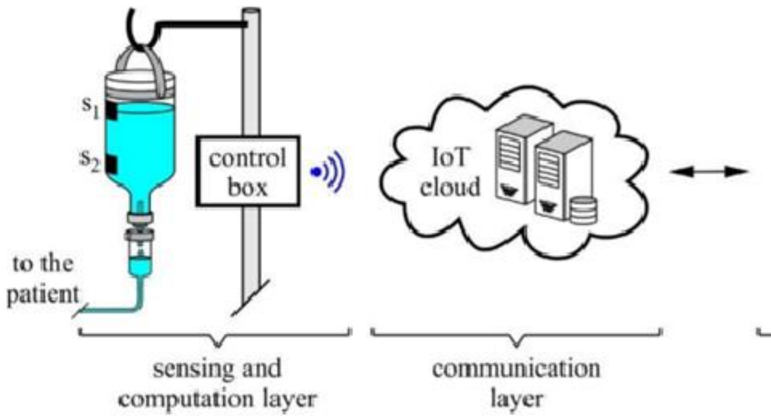
1. Automation and Safety in the Administration of Intravenous Medication: Several studies have stressed the significance of automation in IV infusion to lower medication mistakes and enhance patient safety. Automated dosing techniques can reduce the possibility of human error and improve patient care. To do this, researchers frequently investigate various technologies, infusion rate computations, and decision support systems.
2. Integration of wireless and IoT: In recent years, engineers and researchers have investigated how to integrate IoT with smart infusion systems. By enabling real-time changes, alarm messages, and data analytics for enhanced patient care, these systems can remotely monitor and operate IV infusion pumps.
3. Integration of smart infusion devices with electronic health record (EHR) systems is becoming a more important concern for healthcare organizations. Through this interface, the documentation process is streamlined, manual charting error rates are decreased, and patients are given the right prescription.
4. Usability and human factors: It's crucial to make sure these systems are easy to use. The human variables involved with smart infusion dosage devices are frequently studied. Studies evaluate these systems' user interfaces, training needs, and effects on clinical workflow.
5. Regulatory recommendations: The U.S. Food and Drug Administration (FDA) and other international organizations set regulatory recommendations that researchers and healthcare professionals closely follow. These recommendations support the safety,

effectiveness, and compliance with quality requirements of smart IV infusion dosing systems.

6. Clinical Implementation and Outcomes: A growing corpus of research has examined how smart IV infusion dosage systems are used in practice and how they affect factors including drug mistakes, patient safety, and treatment effectiveness. These studies frequently include data analysis and case studies from medical facilities.
7. Challenges and Future Directions: Implementing smart IV infusion dosage devices presents a number of difficulties, including costs, compatibility problems, and cybersecurity hazards. Future directions are also being investigated, such as the application of AI to predictive analytics and dynamic dosage modifications.
8. More recent trends are concentrating on how intelligent IV infusion dosage technologies can improve patient-centered care. This includes tools that provide patients more awareness and control over their care, as well as methods for incorporating patient input into dose decisions.

You should search databases like PubMed, IEEE Xplore, and other academic sources for the most recent research papers, articles, and reviews in the field of smart intravenous infusion dosing systems, as well as related topics like smart infusion pumps, medication safety, and healthcare technology integration, in order to conduct a thorough literature review on the subject.

III. BLOCK DIAGRAM



IV. LIMITATIONS AND EXISTING WORK

Cost: SIIDS development and implementation can be pricey. It can be quite expensive to buy and operate smart

infusion pumps, integrate them into current hospital systems, and provide the necessary training to medicalprofessionals.

Existing Research: To lower the overall cost of SIIDS, researchers are looking at cost-effective methods including open-source software and modular hardware.

Issues with interoperability: It can be difficult to make sure that SIIDS can synchronize with multiple hospital information systems, electronic health records, and other devices.

Existing Work: To enhance interoperability, standards like HL7 and IHE are employed. Guidelines and protocols are being developed by researchers and organizations for improved data exchange.

Data Security and Privacy: Given that SIIDS is network-connected, data security and patient privacy are top priorities. Modifying infusion parameters or gaining unauthorized access to patient data might have dire repercussions.

Existing Research: To secure data transmission and access, researchers are creating encryption and authentication techniques. The observance of data protection laws is also a priority.

Accuracy of Algorithms: Dosing algorithms must be accurate. Incorrect data entry or calculations may result in over- or underdosing, which could be harmful to patients.

Existing Work: Ongoing adjustments to dosing algorithms that take into account patient-specific variables are being made. Accuracy is being increased with the aid of artificial intelligence and machine learning.

Human Factors: It is essential to comprehend how healthcare professionals use SIIDS and to build systems that fit their workflow. Usability problems can be caused by poorly designed interfaces or difficult procedures.

Existing Work: To enhance user experience, reorganize workflows, and lower the possibility of errors, human factors engineering, and usability studies are being carried out.

V. CONCLUSION

The study presents an intelligent IV infusion dosing system that provides liquid level detection and signaling in an IV container. Additionally, it enables remote locations, like a nurse room, to monitor and view the IV infusion process in real time. Additionally, it permits automatic control and termination of IV tubing-based infusion flow.It is made up of three main components: the user layer, the communication layer, and the sensor and computation layer.

Using a wireless communication module, the communication layer facilitates coupling and information flow between the first and third layers. Additionally, it offers internet connectivity, allowing for the direct storage of data from the devices in the other two tiers on the cloud server. Additionally, putting the database on a cloud server makes it possible to maintain information on all patients and IV therapies they have received. The data is kept in the microcontroller since the hardware component of the system operates independently if the internet connection is lost. Data are transmitted to the cloud server and to the client (user layer) after the connection is reestablished.

The user layer offers real-time remote monitoring and viewing of each patient's specific IV infusion therapy reception. Additionally, it enables the monitoring room to see a visual display of potential alarms. By connecting to a server through the Internet, client devices, such as smartphones, PCs, and tablets, can access the data. The data are not destroyed, though, and remain on the cloud server even if contact between the client and cloud server is disrupted. Additionally, all that is required to access the data is to enter the IP address in the browser rather than downloading and installing a program for the client.

We can minimize visual controls during IV therapy by using a modern IV infusion system for detection, signaling, and monitoring of fluid levels in the IV bottle or bag at a remote location. As a result, the total distance traveled by medical staff is significantly reduced, implying greater efficiency and better organization of the medical staff. Additionally, the system notifies personnel when IV bottles need to be changed continuously and on time, which can improve the success of IV therapy, particularly in oncology patients when IV bottle drip periods are rigorously mandated. For IV chemotherapy to have the full effect of cytostatics, the recommended drip time must be adhered to, which can only be done with the aid of contemporary equipment for IV detection, monitoring, regulation, and closure.

Finally, it is important to emphasize that the suggested smart IV infusion dosage system cannot now undergo clinical testing due to the COVID-19 virus, but will in the future in compliance with Republic of Serbia law.

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