IoT based Patient Monitoring for Peritoneal Dialysis Patients with DT Approach

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***Abstract*:- Automated Peritoneal Dialysis (APD) is an vital treatment option for patients who are suffering from renal failure. The patients are assisted with the APD device at home. By assisting the device, the survival of life is improved day by day than the patients who are undergoing haemodialysis. Eventhough their survival is improved some patients have been observed with the disorders called Hyperkalaemia and Hypokalaemia due to the chemical reaction of dextrose and the chemical ions inside the body. In hypokalaemia the potassium (K) range decreases upto 3 and below. In hyperkalaemia the K range increases upto 7 and in some patients upto 10 according to their functioning of kidney. The increase in K ion may cause severe heart damage to patients like arrhythmia, shock, heart attack and sometimes to even death.To prevent the patients from the severe damage,the K range is measured continuously and the value is shared to the medical team and care taker of the patient by Remote Patient Monitoring (RPM) system. It provides the ability of sharing the treatment data through a cloud based technology for medical updates of the patient and provides an opportunity for high-quality, timely services based on data transmitted from the patient's home.**

Keywords : Automated peritoneal dialysis, Remote patient monitoring, K=Potassium,hyperkalaemia

I.INTRODUCTION

Potassium disorders are a potentially serious condition that can result in life-threatening cardiac arrhythmias and is associated with an increased mortality risk. One of the most common electrolyte complications are Potassium abnormalities in hospitalized patients. Potassium is one of the critical electrolytes involved in various cellular activities Patients who have an advanced stage of chronic kidney disease (stage 3 or higher), diabetes, and/or chronic heart failure are at higher risk for hyperkalemia or hypokalemia. Hypokalemia and hyperkalemia are common electrolyte disorders which can occur for a peritoneal dialysis patient caused by changes in potassium intake, altered excretion, or transcellular shifts. Diuretic use and gastrointestinal losses are common causes of hypokalemia, whereas kidney disease, hyperglycemia, and medication use are common causes of hyperkalemia. Severe hyperkalemia is an uncommon electrolyte abnormality in patients undergoing maintenance peritoneal dialysis (PD Hyperkalemia can cause an abnormal heart rhythm which can result in cardiac arrest and death. And therefore we empathize the issue of Potassium loss in the body affects the quality of life of the patient and increases morbidity and mortality. So, it is very important to monitor the potassium levels, initiate the standard treatment immediately and normalize them.

Hence in this study, we aimed to capture the data regarding the potassium abnormalities in the hospital setting and understand the causes and their management strategies. In normal individuals, potassium homeostasis is maintained very delicately, governed by the mechanisms of daily potassium consumption and renal excretion. We collected the information from various hospitals during our intern and interacted with some of the peritoneal dialysis patients and their caretakers and sorted out an idea to meet their requirements. Therefore the idea proposed is evaluating the prevalence of potassium imbalance to avoid the risk of hypokalemia and hyperkalemia.The main scope of the project is to monitor the vital parameters during the dialysis procedure, detect the range of potassium level in the patient after the dialysis, update and share the details to the doctor or the care taker of the patient inorder to know the continuous update of the treatment and that of the patient to the procedure. The platform also has the ability to enable PD prescription changes remotely, by the PD nurse at the hospital directly through to the individual patient's PD device at home. The prototype which we made consists of three main sensors (Potassium sensor, Temperature sensor, heart rate sensor) and it is based on IOT data sharing.

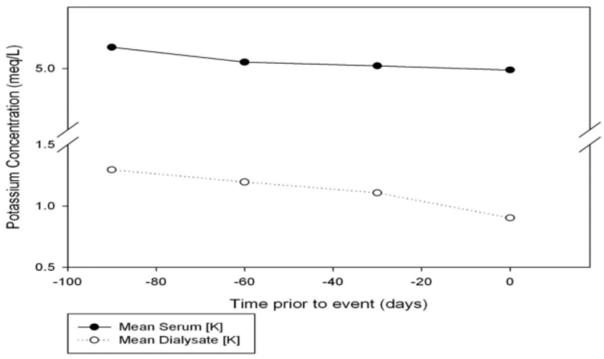

FIG 1. Sample reading graph above depicts the dialysate with 1.5% dextrose resulted draining 6k

II.REMOTE PATIENT MONITORING

IT-enabled patient monitoring systems are increasingly being deployed in chronic disease management. RPM uses information and communication technologies to transfer medical information from the patient for the delivery of clinical and educational services with an aim to improve health outcomes. Collection of information is being increasingly automated with the help of application programming interfaces and sensors that allow seamless capture and transmission of parameters from multiple sources to the system in real-time. RPM provides a framework for monitoring patients at home by digital wireless technology and facilitates the extension of the continuum of care into the patients' home setting through interactive technological interfaces. These technologies have the potential to improve clinical outcomes through improved patient engagement, and earlier recognition and correction of impending complications.RPM provides an opportunity to increase the uptake and technique survival of the home dialysis modalities by improving patient satisfaction and outcomes, and lead to cost savings.

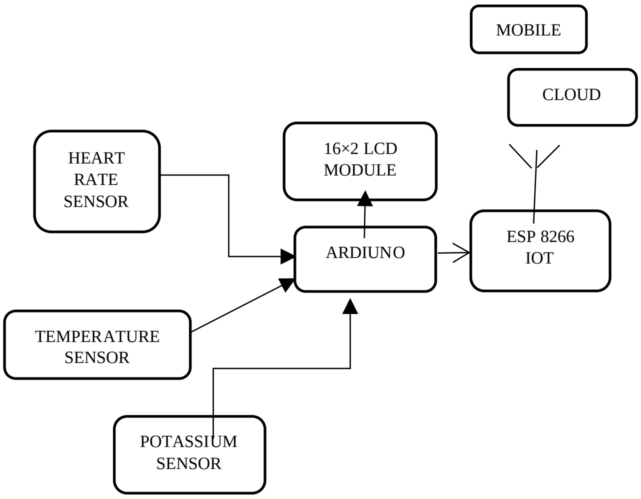

FIG 2 RPM processing system

III.COMPONENTS AND WORKING

Three sensors are contained in data sensing module such as temperature sensor, heart rate sensor and potassium sensor. When the power is turned on, all the LEDs on PCBs starts glowing, indicating that circuit is working properly. Here there is a use of the industrial temperature sensor i.e. LM 35 which gives us body temperature in °C. That temperature is displayed on the LCD. The output of each sensor is interfaced with Analog to Digital circuit (ADC) pins of microcontroller. Data processing module consists of ATmega328, 28-pin 8-Bit microcontroller of Harvard architecture which is a high-performance nRF circuit used to solve problems in conversion of RS232 signal voltage to TTL voltage and needed to communicate the receiver and sending SMS through information gateway, LCD is used as a display unit in connection with microcontroller for displaying the current details of physiological parameters. There is a cavity for measurement of the heartbeat, which consist of an arrangement of LED and LDR. Patients' finger in placed between LED and LDR, and the heart pulses are detected. The analog voltages are further processed with an operational amplifier LM 358, and this chip has two built in OPAMPs. Result is displayed on the LCD. This collected data is transmitted using nRF24L01 module. This data is received at the receiver section using same nRF24L01 module.

3.1 POTASSIUM DETECTION

After the peritoneal dialysis procedure the dialysate waste is collected in the waste bag.A Potassium sensor which is inserted in the waste bag detects the range of the potassium from the waste. A urine potassium level below 20 mEq/L suggests impaired renal excretion. A urine potassium level above 40 mEq/L suggests intact renal excretory mechanisms, implying that high intake or failure of cell uptake is the major mechanism for hyperkalemia. After the detection of the potassium from the waste the result from the LCD display shows the possibility of hypokalemia or hyperkalemia.

3.2 IOT BASED DATA SHARING:

The impact of Internet of Things has been revolutionized in all fields of life, but its impact on the healthcare system has been significant due to its cutting edge transition. The mobile computing extends the functionality of IoT in healthcare environment by bringing a massive support in the form of mobile health (m-health). The IoT brings smart healthcare system in the medical field which is usually composed of sensors with smart functionality, a remote server, and the network. This system is focused to provide monitoring with multi-dimensional features and basic treatment suggestion. The primary actors involved are patients, guardians, physicians. The obtained treatment data is shared to the mobile of the care taker or the patient's physician through cloud based technology. This helps in the daily assessment of the patient details and continuous monitoring after every dialysis procedure. Necessary steps will be provided in case of any risk of potassium imbalance by the physician after analyzing the potassium range of the patient

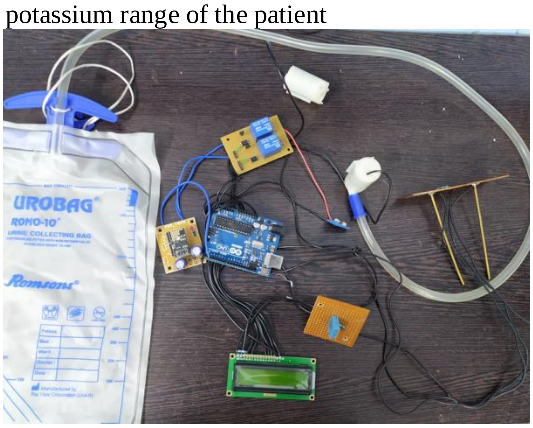

FIG 3.2.1 RPM Processing System

III.CONCLUSION

Remote patient monitoring of the dialysis treatment at home may improve home dialysis patient care, reduce health care costs, and improve patient quality of life. This demonstrates a significant reduction in hospitalizations, hospital days, and emergency department visits among dialysis patients using RPM compared with

patients using traditional care. Remote patient monitoring may be a valuable tool to improve the quality of PD care and clinical outcomes, enabling effective connectivity between patients and clinicians and paving the way toward improved individualized care As technologies advance, early recognition of signs and symptoms of forthcoming complications such as fluid overload, heart failure, peritonitis or sepsis through leveraging the emerging computational techniques in machine learning and artificial intelligence could help prevent or postpone hospitalization and avert the related costs. The proposed system has proven to be an effective method to analyse the risk of hypokalemia and hyperkalemia in the patient.

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