PORTABLE DIALYZER -HEMODIALYSIS BASED

(FOR PATIENTS WITH END STAGE RENAL DISEASE)

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ABSTRACT :

Portable Dialyzer is hemodialysis based process that helps the patients with end stage renal disease to do dialysis on their own without being hospitalized. End stage kidney failure patients are provided with the hand held bag that can be worn by a patient in such a manner that it will not interfere with normal physical activities. It consists of Peripheral Interface controller, filtration device , flow sensor and a battery, by which patient can perform dialysis by switching on the battery whenever they are free . Bluetooth module is fixed to control the process by means of mobile phones . The main advantage is that the patient can do dialysis anywhere ,anytime without the help of doctors or instructors .

1. INTRODUCTION :

In end-stage kidney disease(i.e., when the glomerular filtration rate goes below 15) the kidneys fails to filter the waste, excess salts and fluids from the blood. A kidney transplant is the only solution for most patients with end-stage kidney disease, but the availability of donor was minimum . In 2014, 1,430 Canadians received kidney transplants, 3,473 were still on the waiting list, and 67 people died while waiting for a kidney transplant. Dialysis is the only other treatment options for patients with end stage renal disease to compensate for some of the lost kidney function by removing excess fluids and metabolic wastes such as urea , creatinine that gets accumulate in the blood. Although dialysis removes fluids and wastes, it does not replace the kidneys' function .

Hemodialysis: In hemodialysis, a patient is connected to a machine .By doing minor surgery on the patients arm aterio venous fistula is formed by the legation process of artery and vein. An anti coagulant such as heparin is added to prevent blood clots. Through aterio venous fistula the patient

blood is taken to machine that circulates their blood through a membrane (dialyzer).

The membrane acts as a semi permeable membrane that removes waste products from the blood while at the same time returning other elements, such as blood cells back to the patient's body. Hemodialysis can be performed in dialysis centre with different durations of treatment for each patient , usually have three times and three to four-hour sessions each week.

Peritoneal dialysis : Peritoneal dialysis uses the patient's peritoneum (the membrane lining the inner wall of the abdominal cavity, which acts as a semi permeable membrane) to remove wastes. A catheter is inserted into the patient abdomen through which Dialysate (a pre-packaged solution of purified water, glucose, and minerals) is placed in the abdominal cavity. For a few hours, dialysate remains inside the abdomen allowing wastes to filter from the blood vessels in the peritoneum into the dialysate solution. The dialysate is then drained from the abdominal cavity through the same catheter used and replaced usually three to five times per day, seven days per week.

Limitations in current practice: During dialysis treatment the patients must avoid foods in which salt contents are high , and limit their consumption of fluids. Other Supplements and medications should be taken to replace nutrients lost during treatment and post-treatment fatigue is common. Conventional hemodialysis machines are heavy, need to be connected to an electrical outlet so that the patient's mobility is restricted for many hours during treatment. The out-of-pocket costs of hemodialysis or peritoneal dialysis may be a barrier for some patients. These costs include increased utility of water and electricity, dialysate and transportation costs of travelling to and from dialysis treatments several times each week can also cause difficulty, particularly for elderly patients and those in remote areas .

Proposed work With the advancements in technology ,the above mentioned limitation which are associated with ordinary dialysis treatment can be overcome by developing a wearable portable dialyzer ,that can be worn by a patient and can be activated whenever they are free which will take the blood from the body and filter the waste and replenish the nutrients that are vital for the human body.

The device make patient lives easier for dialysis treatment and lower the mortality rate for chronic kidney disease by reducing anxiety .

2. LITERATURE SURVEY:

Literature review was based on blood purification methods . The currently performed blood purification methods was dialysis either hemodialysis or peritoneal dialysis .The major constraints noted in the current practice was , the patient has to visit the hospital 3 to 4 times a week so they can't plan for any family or business trips since they had to be in the hospital at the scheduled time .To limit this wearable artificial kidney (peritoneal based) was developed in 2015 but this was also unsuccessful because a catheter was fixed in the abdomen permanently it leads to

pertonititis. The above mentioned failures can be limited in this work by developing a wearable device that will not interfere with normal physical activities , but purifies the blood by removing excess salt.

3. METHODOLOGY:

In our proposed work the impure blood or urine(contains excess salt, urea, creatinine which gets accumulated in the blood due to the failure of the kidney i.e., end stage of renal disease) is taken in a bottle instead of taking from a patient with end stage renal disease.

The working of portable dialyzer (hemo dialysis based) is shown in figure 1.

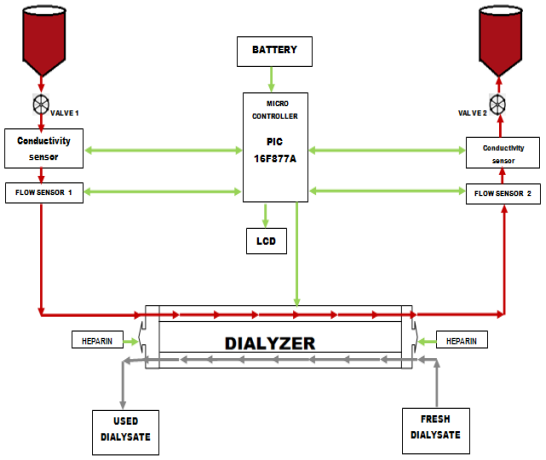

Fig 1: Block diagram of portable dialyzer

In our work peripheral interface controller was used to control the process and it was activated by 12v battery . After activation it sends command to the solenoid valve (inlet and outlet) to get open . The solution mixed with waste and excess salt taken in a bottle which comes out once the valve get opened.

Heparin (anti coagulant) is added in order to prevent from clotting. Mixture of solution and heparin is pumped into the dialyzer. At the same time the fresh dialysate (mixture of purified water and minerals) is added to the dialyzer in the opposite direction . In the dialyzer the diffusion and ultra filtration takes place (movement of solute from a region of higher concentration to a region of lower concentration) ,by which the excess salt and waste moves to the dialysate from the solution and the used dialysate is collected back at the other side of the dialyzer through which it enters . The purified solution comes out of the dialyzer, Again the heparin is added to prevent clotting at the outlet, and it was pumped to the bottle through the opening of solenoid valve.

3.1: HARDWARE DETAILS :

3.1.1: PCB:

A printed circuit board consists of a copper tracks placed on a conducting sheet . The circuit diagram of our work was printed and the components was placed and soldered. Hence it reduces wiring thereby reducing the faults due to lose connections.

3.1.2: DIALYZER:

Dialyzer is used for purification of blood /fluid /urine . It uses a semi permeable which acts as a filter that removes excess salt from the inlet .The remaining essential constituents in the inlet is pumped out to the bottle ,but in real case it is pumped to the patient body.

3.1.3: PIC(16F877A):

Peripheral interface controller comes under CMOS (complementary metal oxide semiconductor) family which is a 8 bit microcontroller that control and activates all the process and components in our proposed work .Another reason for using (PIC16F877A) is it can be used to add extra features to this work in future , requires very little power .

3.1.4: BATTERY:

A 12 volt battery is used to activate the PIC (16F877A) and a dialyzer , resistors and capacitors are used as a filter circuits.

3.1.5: LIQUID CRYSTAL DISPLAY :

It is a display with flat panel and uses two rows for displaying the values. Principle behind LCD was light modulating properties .The value displayed in our work consists of amount of urea contained before and after dialysis .

3.1.6: BLUETOOTH MODULE:

Bluetooth module is used to synchronize the hardware and the android mobile phones by MIT software. The opening and closing of solenoid valve through the mobile phone helps the person using portable dialyzer .

3.1.7: SOLENOID VALVE :

It is operated by electromechanically . The valve is used for opening and closing of the inlet and outlet . So that there is a flow between bottle to the dialyzer and vice versa.

3.1.8: FLOW SENSOR :

To make a controlled flow of the fluid , the flow sensor is used which measures the flow rate of the inlet and the outlet .

3.1.9: VOLTAGE DIVIDER:

It is a passive linear circuit that produces output voltage which is a fraction of input voltage . It commonly divides the input voltage and distributes among the components of the circuit.

3.1.10: RELAY :

Relay is used in order to make the solenoid valve to open and close.

3.2: **SOFTWARE DETAILS :**

In our proposed work **Embedded C** was used for the execution of the hardware . **CCS compiler** are specially designed to meet the needs of PIC microcontroller which includes conversion of higher level language to the lower level language since the PIC (16F877A) can understand only lower level language and they are more readable .

MIT software was used to control the solenoid valve through mobile phone by Bluetooth module.

4. RESULTS AND DUSCUSSIONS :

In this proposed work we have developed an prototype that will assist the kidney function by removing excess salt , urea , creatinine from the blood thereby improves patient quality of life . The patients with end stage kidney disease are benefited by using this portable dialyzer , since the

device is compact in size which can be fitted in a bag that can be worn by a patient when they are free . They can also perform purification process during their regular work but the normal physical activities will not be affected and it allows patients to eat and drink without any dietary restrictions on fluid intake and on foods that contain salt, potassium, or phosphorus, So the need for supplements and medications during the treatment (such as phosphate binders) may be reduced . It further reduces the time and costs for in-centre treatments , i.e., actual clinical practice for blood purification methods(dialysis).

Limitations:

Even though this work has several advantages it has a limitation like the patient using this device has to add fresh dialysate during each time of purification.

FUTURE WORK :

In future the patient body parameters (such as blood pressure, temperature) can also be monitored using an appropriate sensor. Further the patient body heat can be used to supply power for components instead of harvesting energy from a battery by thermo electric generator.

CONCLUSION:

The patient with end stage renal disease can use this device without any medical professionals and more effectively.

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