Diagnosis of Vascular Access for Hemodialysis Using Software Application

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Abstract. Sufficient blood flow in arteriovenous shunt (AVS) is one of the key parameters for successful and effective hemodialysis treatment. The development flow is monitored using a blood temperature monitor (BTM), which is a module which based on the thermodilution method can measure recirculation in the AVS. From the measured recirculation, then we can calculate the flow rate in AVS. Subsequent calculations and interpretation of measured data has to choose the appropriate type of software that users, and physicians provides a comprehensive picture of the patient's vascular access. Flow measurement in vascular access AVS in the department of chronic hemodialysis has long been monitored by Doppler ultrasound examination, which is considered a basic examination. Flow measurement in AVS using BTM module can be considered as an alternative method of measurement.

Keywords: Arteriovenous shunt · Vascular access · Dialyzer · Hemodialysis · Hemodialysis monitor · Thermodilution · Recirculation

1 Introduction

Hemodialysis is a method of cleansing the blood, carried out by means of hemodialysis monitor acute or chronic renal failure. Dialysis is the transfer of substances through a semipermeable membrane. Blood purification is based on biophysical principles such as diffusion, convection, ultrafiltration, adsorption and osmosis [1, 2].

Hemodialysis monitor consists of a system of extracorporeal blood circulation to enable the safe collection of blood from the vascular access for patients and safe return of blood back to the patient (see Fig. 1). Basic elements of the extracorporeal blood circulation consists of a dialysis needle (or catheter), which are input and output of a patient's blood. The dialysis set, head over blood safety features to the dialyzer and back to cleaning. Taking a dialyzer can be considered as a key element of extracorporeal circulation, since it is used for the purification of blood [3].

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2 Vascular Access

Surgical creation of arteriovenous connection that is used to re-connect the patient to hemodialysis, one of the basic vascular surgical procedures. By this operation is the creation of arteriovenous shunt, or shunt (AVS) which can be easily cannula and can withstand repeated punctures. Securing adequate blood flow is necessary for efficient operation of the hemodialysis apparatus. Even after surgery perfection but life AVS limited and depends on many factors. We distinguish between temporary and permanent vascular access vascular access [4].

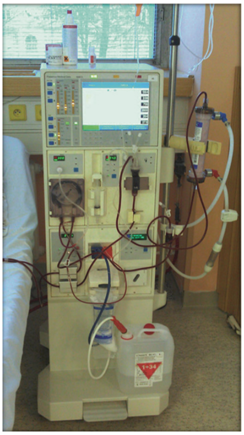

Fig. 1. Monitor fresenius hemodialysis.

Temporary vascular access for aid venous catheter is de-signed for a limited number of performances (one or more) and use it for all patients who require acute perform any of dialysis methods, most hemodialysis. Also, it is used in patients on chronic dialysis program, the permanent vascular access cannot be created [3].

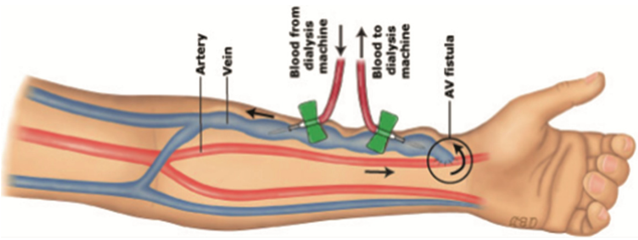

Fig. 2. Vascular access (AV shunt, fistula).

Permanent vascular access is chosen in patients when hemodialysis and its related techniques are repeated at regular intervals (e.g., 2 to 3 times per week) for a period not months but years. Italians Cimino and Brescia in 1966, was first used by native subcutaneous arteriovenous shunt (fistula, shunt) when sewn to the artery vein (see Fig. 2). Most frequently used connection between the radial artery and cephalic v. the non-dominant limb, rarely is then used connection between the brachial artery and cephalic v. or femoral artery and saphenous vein. The resulting "short-vein" to expand the influence of hemodynamic conditions, arches over nivaeu and is then easily accessible to puncture [2, 3].

3 Recirculation

Situation where in the dialyzer together with the non-adjusted blood flows and certain amount of blood that has flowed dialyzer and back into it returns without flow through the organism, the term function (see Fig. 3). Ideally enters the dialyzer from the arterial needle a given amount of blood (QB ml/min), after flowing through the dialyzer returns venous needle set and into the bloodstream. All cleaned blood flows downstream into the central venous system into the dialyzer inflow of new blood falsetto. However, it may happen that part of the already adjusted blood does not flow into the central venous system, but it gets back to the arterial needle and returns to the dialyzer, or recirculated. This situation is referred to as recirculation in the vascular access. Recirculation occurs under two circumstances. Either Exchanged placement of needles or blood flow to the dialyzer exceeds the total blood flow fistulas [5, 13, 15].

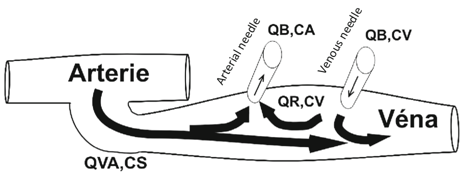

Fig. 3. Recirculation in AV shunt (free reposted F. Lopot 2012 [6]).

3.1 Measurement of Recirculation

For this purpose, can be used dialysis monitor equipped with temperature monitor blood BTM (blood temperature monitor). The temporary change in temperature of dialysate inflow into the dialyzer is created bolus temperature, which is transferred to the blood side of the dialyzer. Cooling the dialysate for 2 min, the cooling of small volumes of blood, at 35 °C. Thus cooled blood is detected by a sensor in the venous set. Another sensor allows capture decrease in arterial blood temperature set by recirculation. It is a method of "on-line" and the waiting staff very simple. Value recirculation appears on the display for about 2 min at the touch of a button. Thermodilution method can also be used to calculate blood flow fistulas [5, 7–10].

4 Analysis and Results

Evaluation of the development of AVS flows derived from Doppler ultrasound (ultrasound) hemodialysis centres Faculty Hospital in Ostrava. The aim of this study was to determine whether the long-term trend is prevailing development flow AVS increasing or decreasing. Monitoring were 8 patients who underwent regular ultrasound over 6 years. Analyzing the data, it was possible to demonstrate the changing flow of the AVS over the years. Graphic development flow AVS is always interspersed with linear trend, this development follows. The resulting analysis of the data obtained during the reporting period (see Fig. 4) in these patients is the declining flow in AVS during the few years since its inception.

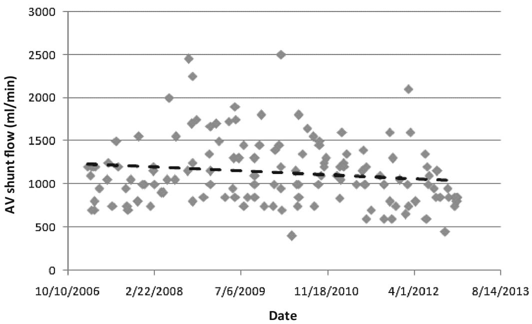

Fig. 4. The final analysis of the development flow.

Were also analyzed results obtained from a hemodialysis center in Vsetin derived from BTM module hemodialysis monitor Fresenius 4008S. From the imposing number of measurements obtained 391 was created histogram showing the distribution of ratings QVA occurrence of flow. Results forms a bell curve, with the highest incidence occurred in the flow range 700–1000 ml/min. Another objective was to determine the long term with the prevailing trend. Due to the diversity of patients aged measured at different intervals were chosen group of patients whose measurements are repeated regularly over the years and whose frequency of occurrence of the selected 391 measurements were highest. Chosen were 7 patients who were regularly at BTM module measurements during 5 years. The resulting trend of the patients again showed a gradually decreasing.

In order to justify the measurement obtained from the BTM module needed its own measurements for evaluating the accuracy with which it can be used during hemodialysis process measured. Measurements were carried out on eleven patients of which 5 women and 6 men. In total, 24 measurements were acquired. The goal was always com-paring measurements obtained from BTM module with the current result obtained using Doppler ultrasound examination. Out of 24 measurements, measuring 19 (79 %) was the difference of 15 % and 5 measurements (21 %) with a difference of more than 15 % compared to ultrasound. Based on the measurement and evaluation of their results, we can say that the AVS for flow measurement in routine clinical practice at the bedside BTM module is sufficiently precise and therefore satisfactory (see Fig. 5).

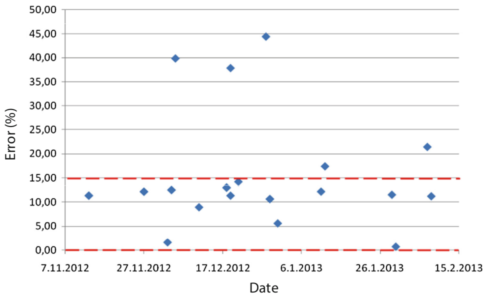

Fig. 5. Analysis of measurement accuracy BTM module.

5 Software for Evaluation of the Measurement Patients

To facilitate control, flow calculation and evaluation of the state of flow in AVS in terms of the time horizon was made program, which has a staff of hemodialysis centers to facilitate its work. With this program, the physician obtains the necessary overview of developments in the vascular access, who may be helpful in assessing its long-term condition. The program has a particular task to calculate the flow rate of the AVS data obtained from BTM module, and the data for a particular patient clearly interpret the doctor whenever he could analyze the results. The program has a simple user interface (see Fig. 6) and the window where the patient enters basic information about the patient, window measurement protocol, which entered data obtained from measurements at BTM module graph of flow in the AV shunt created a database of patients. The data stored for each individual patient can then be retrieved and updated at any time [11, 14].

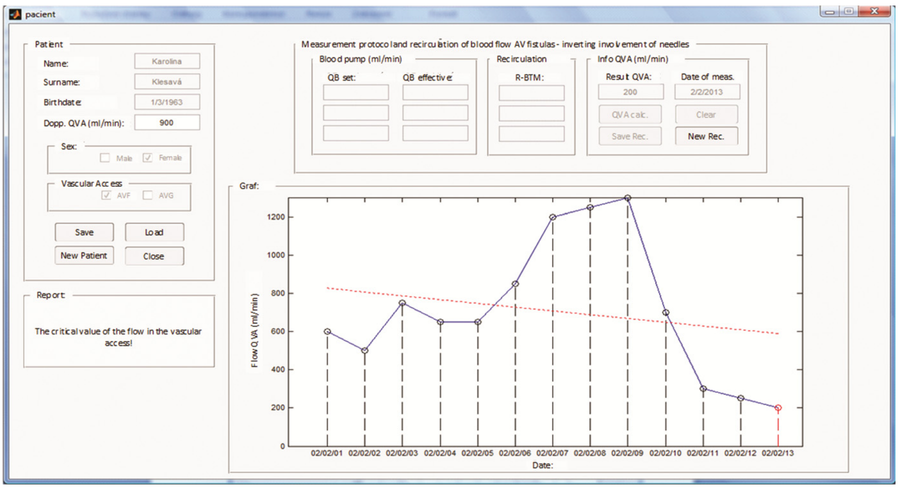

Fig. 6. User interface SW.

After starting the program, the user can establish a new patient or retrieve stored measurements. If the user decides to create a new patient must fill out all data in the protocol called "patient". In this protocol, the user enters the name, surname, date of birth (dd/mm/yyyy) fills the last known result in vascular access flow derived Doppler ultrasound examination, selects gender and type of vascular access AVF (AVS of native vessels) or AVG (AVS artificial material). If the protocol is completely filled with the patient presses the save button [12].

The measurement protocol recirculation user fills in the details of the haemodialysis monitor and blood flow to the pump set and effective (Fig. 7).

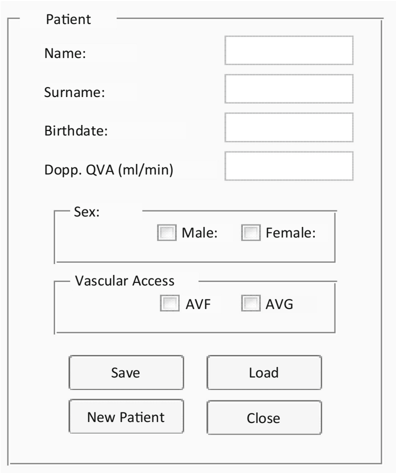

Fig. 7. User interface SW patient.

From module BTM user then logs the recirculation appropriate value (see Fig. 8). When this protocol being fully completed, the user presses the button to calculate QVA. After successful completion of the calculation is displayed in the log info QVA field result QVA. The final step the user fills measurement date (in the format dd/mm/yyyy) Protocol QVA info. Press to save the recording is the result QVA stored along with the date of measurement in graphical form.

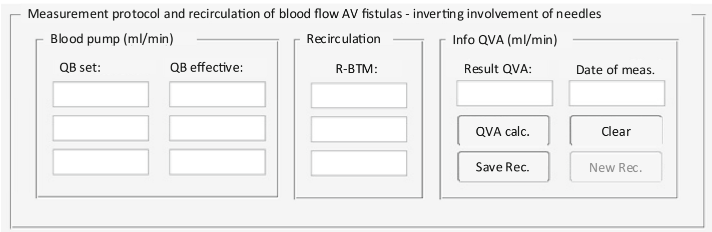

Fig. 8. User interface SW protocol.

In the case that the flow in the AVS will be lower than the limit, the user is notified both in graphic form (Fig. 9) colorfully while announcing the result actually field message. For the stored measurements of a given patient, the user can browse at any time by pressing the Load button. The user selects a patient who wants to explore or continue existing measurements.

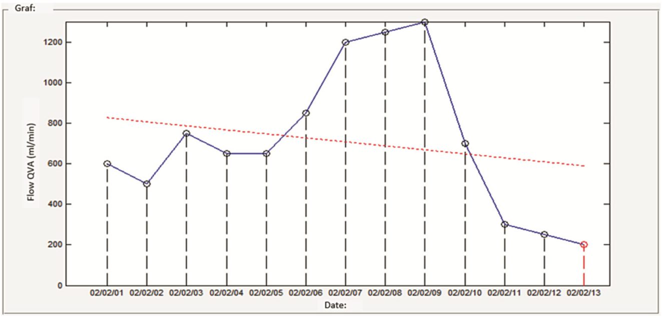

Fig. 9. Graphic design of measured data (Color figure online)

6 Conclusion

Evaluation of the development of AVS flows derived from Doppler ultrasound examination of the hemodialysis centers Faculty Hospital in Ostrava. The resulting analysis of the data obtained during the reporting period, the declining flow in AVS during the few years since its inception. Were also analyzed results obtained from a hemodialysis center in Vsetin derived from BTM module Fresenius hemodialysis monitor. The resulting trend of the patients again showed a gradually decreasing. Furthermore demonstrated the accuracy of measurement BTM module. Based on the measurement and evaluation of their results, we can say that the AVS for flow measurement in routine clinical practice at the bedside BTM module is sufficiently precise and therefore satisfactory. Given the above, it is appropriate to regular check-ups AVS. Designed and described SW is the path could continue interpretation and storage of collected measurement data.

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