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CONSIDERATIONS ABOUT ELECTRICAL SAFETY IN THE DIALYSIS PROCESS

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Abstract: *The dialysis process is an extra corporal epuration method of the patients blood by the toxins resulted in the metabolic process of the human body. It is applied when the kidneys can't achieve their normal functions, by using a dialysis apparatus and a dialyzer. During hemodialysis, the dialysis liquid is conductive and allows a current to flow from or to the machine if a difference in electrical potential occurs, so it can deliver accidental electrical currents from the dialysis apparatus to the patient. This may cause a health risk for the patient. Therefore it is necessary to verify the electrical safety of the dialysis apparatus by the dialysis technicians with a specifically measurement instrument using an adequate measurement circuit, proposed by this paper.*

The paper presents same results of electrical safety measurement of the tested dialysis machine using the proposed circuit.

Key words: *dialysis, risk, safety*

1. INTRODUCTION

Dialysis is a medical treatment applied to the patient with kidneys deficiencies. It consists in the epuration of the blood by the toxical substances (urea, creatinine) resulted from the metabolic process.

The kidneys functions are replaced artificially by using a specialized apparatus (dialysis apparatus).

The extracorporal epuration is based on the transfer of the substances through one semi permeable membrane between the blood and the dialysis liquid which are vehiculated in the dialyzer. The dialysis liquid is prepared by the dialysis apparatus using concentrated active liquids and water for hemodialysis. (Bonnie-Schorn et al., 1998)

The epuration of the blood is happening outside of the human body in the dialyzer, which is connected, to the dialysis apparatus and to the patient by an extracorporal circuit.

To make possible the connection between the patient and the dialysis apparatus it is necessary to make a permanent vascular access (arteriovenous fistule).

Due to the composition of the dialysis liquid which is conductive during hemodialysis it allows a current to flow from or to the machine if a difference in electrical potential occurs, the major problem is that this may cause a health risk for the patient.

During dialysis the patients are exposed to a permanent risk because their blood is circulated and filtered outside from their body, therefore it is very important to identify these risks for the patients and realize a permanent quality control to avoid these risks. (Ianosi, 2004)

The basic constituents of the dialysis process are the water treatment system, the dialysis apparatus and the choosed treatment parameters (type of the dialyzer, hydraulic parameters of the flowing liquids and time of the dialysis sitting).

Taking into account these aspects the risks for the patients treated by dialysis (Ianosi, 2004) can be classified in the following categories:

- Risks coming from the water quality;
- Risks coming from the inadequate working of the dialysis apparatus;
- Risks coming from the choosed treatment.

The aspects of identification and evaluation of electrical safety risks in the dialysis process are not sufficiently taked into consideration (***, 2002) so the author identified these risk categories (Ianosi, 2004) and considers that the electrical safety of the patients can be included in the category of risks for inadequate work of the dialysis apparatus.

2. PROPOSED METHOD

To realize the electrical safety test for dialysis apparatus the following electrical schema is presented, with MD as measurement device, as shown in fig. 1.

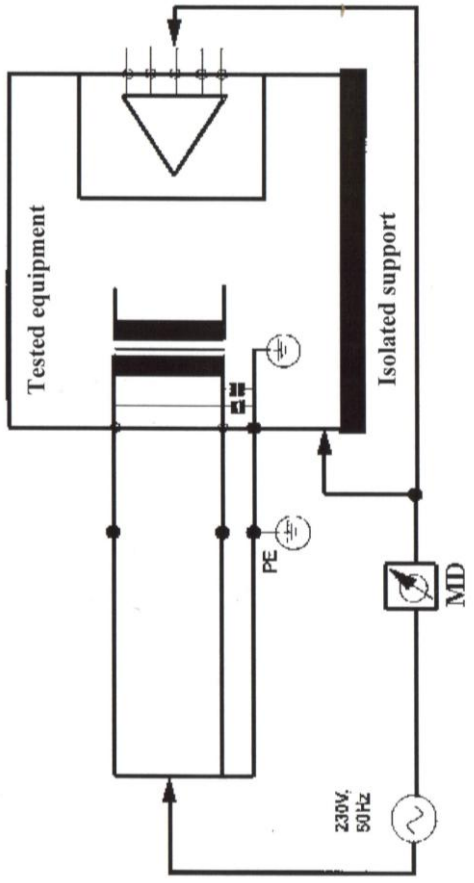

Fig. 1 Electrical scheme for the electrical safety test

To ensure the measurements reproducibility the tests were made taking into consideration the following measurement conditions (***, 1989):

- Ambient temperature: 15 to 35 °C
- Relative humidity: 45 to 75 %
- Atmospheric pressure: 645 to 795 mmHg
- Electric supply : 220 V ± 10 %, 50 Hz ± 1 Hz

- Water supply:
  Pressure: 140 to 500 KPa (1,4 to 5 bar)
  Temperature: 10 to 30 °C
- Reference „arterial" pressure : - 100 mmHg
- Reference venous pressure: 125 mmHg

The electrical safety test was made for the AK 200 dialysis apparatus. Current leakage measurements were performed without connection of the patient to the system by using a copper tube inserted into the stream of the dialysis fluid at the point where the patient would normally be connected to the dialyzer, as shown in fig. 2.

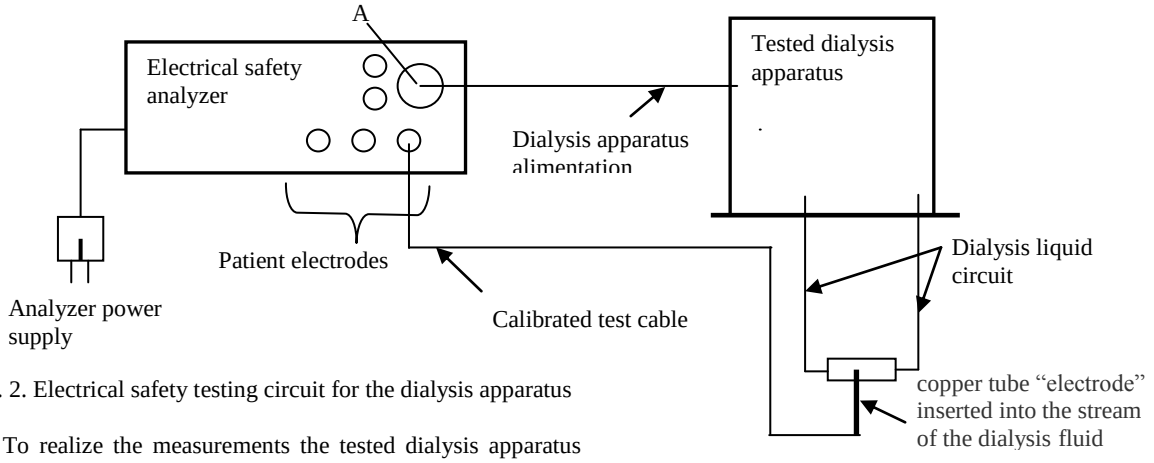

Fig. 2. Electrical safety testing circuit for the dialysis apparatus

To realize the measurements the tested dialysis apparatus was connected to the electrical safety analyzer at the port A. (see fig. 2)

The used electrical safety analyzer was Metron QA-90 (***, 2001) which contains an ampermeter, a voltmeter and a mega-ohm-meter to the measurement of the isolation resistance, according to the IEC 60601-1-1 standard (***, 2000).

3. EXPERIMENTAL RESULTS

Using the testing circuit presented in fig. 2 the following experimental results was obtained, as shown in Tab. 1.

Tested parameters	Limit values	Measured values	Obs.
Isolation resistance	> 200 MΩ	> 200 MΩ	Test ok
Lake current to the ground	500 μA	106 μA	Test ok
Lake current to the frame	500 μA	106 μA	Test ok
Lake current to the patient	500 μA	93 μA	Test ok
Absorbed current	-----	186 mA	Test ok

Tab. 1. Experimental results

The current leakage to the ground and the current leakage to the frame (measured in μA) were higher as the current leakage to the patient, which is indicating the safe working mode of the tested apparatus.

Analyzing the obtained results we can conclude that the analysed dialysis apparatus passed the electrical safety test.

4. CONCLUSIONS

During dialysis the patients are exposed to a permanent risk because their blood is circulated and filtered outside from their body, so it is very important to identify the risks for the patients and realize a permanent quality control of the medical devices to avoid these risks.

The dialysis liquid is an electrical conductor so it can deliver accidental electrical currents from the dialysis apparatus to the patient, which may cause a health risk for the patient.

Therefore it is necessary to verify the electrical safety of the dialysis apparatus by the dialysis technicians with a specifically measurement instrument (electrical safety analyzer) using an adequate measurement circuit, as shown in fig. 2.

To prevent the risks and to ensure the safety of the patients in the dialysis process it is recommended to:

- Provide an adequate utilization of the dialysis apparatus and the consumables by the medical personnel (nurses);
- Realize a preventive maintenance by the technical personnel;
- Stop immediately the dialysis if the apparatus presents anomalies in its function;
- Make the auto test for each dialysis sitting to verify the proper function of the dialysis apparatus;
- Be sure that after all technical interventions the dialysis apparatus is given in use only after checking all its functions followed by the specifically disinfection procedures, which has the major objective to achieve adequate safety of the patient by the dialysis apparatus and the water treatment system.

The greatest risk may occur when the patient also is connected to other electric devices with current leakage.

The future research work consist in analysing other types of dialysis apparatus using the same measurement conditions and realise an evaluation of the electrical safety comportment of the analysed medical devices.

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