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A new infusion pathway intactness monitoring system

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***Abstract*— A new infusion pathway monitoring system has been developed for hospital and home use. The system consists of linear integrated circuits and a low-power 8-bit single chip microcomputer which constantly monitors the infusion pathway intactness. An AC (alternating current) voltage is induced on the patient's body by electrostatic coupling from the normal 100 volt, 60 Hz AC power line wiring field in the patient's room. The induced AC voltage can be recorded by a main electrode wrapped around the infusion polyvinyl chloride tube. A reference electrode is wrapped on the electrode to monitor the AC voltage around the main electrode. If the injection needle or infusion tube becomes detached, then the system detects changes in the induced AC voltages and alerts the nursing station, via the nurse call system or PHS (personal handy phone System).**

I. INTRODUCTION

Infusion drips are used for treatment in hospital and at home. There are many systems for monitoring infusion conditions such as pressure and drop counting; however, there is no previously developed infusion flow pathway monitoring system.

In this study, a new infusion intactness monitoring system has been developed for hospital and home use. The system detects changes in the AC (alternating current) voltage induced by electrostatic coupling from the ever-present 100 volt AC power line field around the patient's room. When the injection needle or infusion tube becomes detached, then the system detects the changed ratio of the AC voltages recorded by two electrodes wrapped on the infusion polyvinyl chloride tube, and alerts the nursing station, via the nurse call system or PHS (personal handy phone System).

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II. METHOD

Figure 1 shows the overall infusion pathway monitoring system. The normal 100 volt, 60 Hz AC (alternating current) power line in the patient's room is induced on the patient's body by electrostatic coupling from this field[1]. The AC voltage induced on the patient can be recorded by a main electrode wrapped around the infusion polyvinyl chloride tube. A flexible conductive tape is employed as the main and reference electrodes. The electrodes are 5 cm in length and is wrapped on the infusion polyvinyl chloride tube tubing 40 cm from the needle, as shown in Figure 1.

The AC voltage around the main electrode is recorded by a

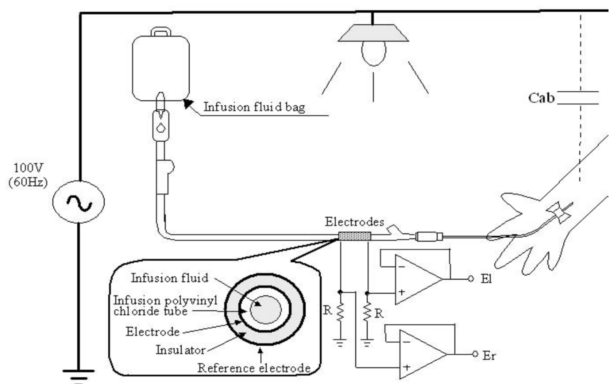

Figure 1 The overall infusion pathway monitoring system.

reference electrode wrapped on the electrode. The system calculates the ratio of the induced AC voltages recorded by the main and reference electrodes. The ratio indicates whether the injection needle or infusion tube is attached. If the injection needle or infusion tube becomes detached, then the alerts the nursing station, via the nurse call system or PHS (personal handy phone System).

III. SYSTEM DESCRIPTION

Figure 2 shows the infusion pathway monitoring system. The system is designed with two high-value input ground-referencing resistors, two impedance converters, two band-pass active filters, two non-inverting amplifiers and a SMC low-power 8-bit single chip microcontroller (Microchip Technology, PIC16F877).

The main and reference electrodes are connected to the impedance converters by shielded cables. Each impedance converter consists of a high-value resistor and a high input impedance operational amplifier. The band-pass filter eliminates interference signals from other electrical devices, so that only 60 Hz is recorded. The RMS/DC converter converts the 60 Hz AC voltage into an effective DC value. The outputs of the RMS/DC converters are digitized at a sampling rate of 20 Hz by the microcomputer's 10-bit A/D converters. The microcomputer detects whether the injection needle or infusion tube is detached, and then the microcomputer alerts the nursing station via the nurse call system or a low-transmitting power personal handy phone (PHS).

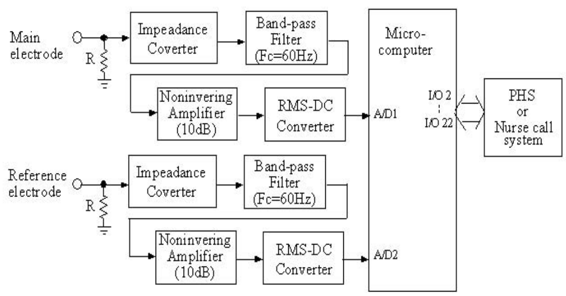

Figure 2. The block diagram of infusion pathway monitoring system.

IV. Results & Conclusion

Measurements were performed on a normal age 58 male subject, of height 175 cm and 68 kg in weight, in a hospital-type adjustable bed (FRANCEBED, FB-660) in a third floor room. The room has 100 and 200 volt AC power lines in the ceiling and under the floor. Three fluorescent lights were attached to the ceiling 2 meters above the bed.

Figure 3 shows the effective DC values for various input resistors recorded under the condition of secure and non-secure infusion pathways in the physiological saline solution. The recorded effective DC values condition of the secure and non-secure infusion pathways increase with the resistance value. The effective DC value with a secure infusion pathway condition was higher than a non-secure infusion pathway. Figure 3(b) shows the ratio obtained under the condition of secure and non-secure infusion pathways. When the injection needle or infusion tube has a secure infusion pathway, then the ratio was 5.5. On the other hand, under the condition of non-secure infusion pathway, the ratio was 1.9. Therefore, this ratio can be used to detect whether the injection needle or infusion tube is detached. A threshold is set to 2.9, which is an intermediate value between the secure and non-secure infusion pathway's ratio.

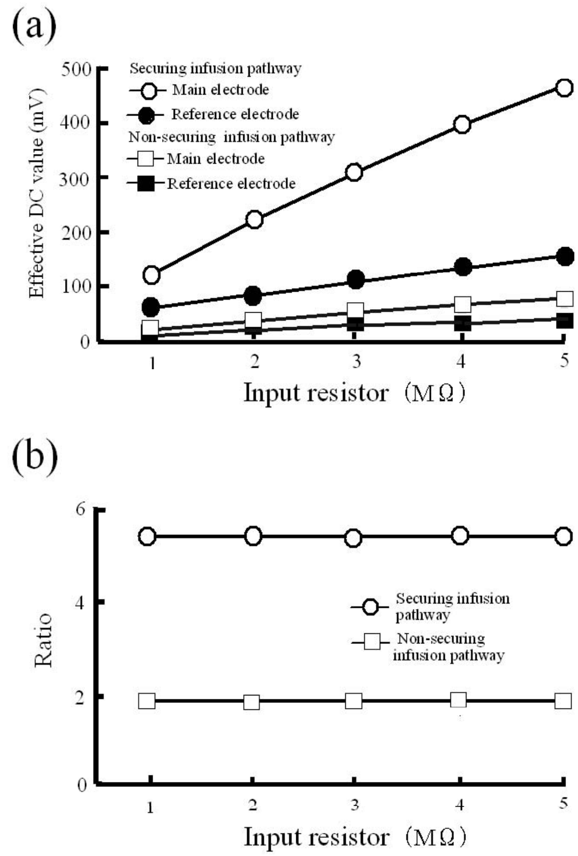

Figure 3. The effective DC values for various input resistors recorded under the condition of secure and non-secure infusion pathways in the physiological saline solution (plot A) and the ratio (Plot B).

The developed system can monitor the infusion pathway by attaching only one electrode to the infusion tubing and is useful for patients in hospital and at home.

References

[1] Yoshiharu Yonezawa, Yasuaki Miyamoto, Hiromichi Maki, Hidekuni Ogawa, Ishio Ninomiya, Koji Sata, Shingo Hamada and W. Morton Caldwell," A new intelligent bed care system for hospital and home patients", Biomedical Instrumentation & Technology, Vol.39,No.4, July/August, pp.313-319, 2005.