Simulation of intravenous pumps' operation

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Abstract

Due to busy traffic in the intensive care units, nurses or physicians are usually challenged to monitor and control the intravenous (IV) pumps. In order to overcome this hurdle, we projected a four-phase research study to develop a nurse console that'll monitor and play with the settings of multiple IV pumps from a central location. In this paper, we studied Phase I that is simply simulation of the operational principles of an IV pump. The second phase is all about development of a Software that will have a settings and displaying window, which will eventually be interfaced to a single pump. Revision of the software to add networking capability to monitor and control multiple pumps that'll be integrated with a PC will take place in the third Phase. The fourth and final phase will aim to convert the communication of the whole system to wireless. Introductory phase software is developed using Delphi 5.0 programming language and this program is to help us understand the working principles of an IV Pump by simulating its setting controls and displaying. In the case of unavailability of IV Pumps for experimentation purposes, this simulation will take the place of the pump itself and will enable us to work in the office conditions rather than carrying IV pumps over from the University hospital. Volumes and flow rates of multiple fluids to be injected to the patient can be controlled and displayed in separate windows. Monitorization of beginning and ending times, capability of starting and interruption of each fluid injection are available in our simulation. The lock panel button simulates the password-protected access to the system and protection from deliberate interventions. Especially, digital screen that shows the amount of fluid already given and left in the bottle are very useful for visualization purposes.

1 Introduction

IV (intravenous) infusion fluid is a fluid used frequently in several units of health centers, especially in intensive care units. This fluid should be administered to the patient intravenously in a certain amount of time. The amount and infusion duration

of the IV fluid to be administered to the patient is usually determined by the physician [1]. Infusion pump is a device, which controls the rate and volume of drugs and fluids administered in different ways including intravenous, subcutaneous, enteral, epidural and intirathecal ways [2,3]. Infusion pump allows drugs and fluids to be injected into the patient in a controlled way in a long period, simplifying complex drug distribution systems. Rate adjustments allow us to control the infused amount.

Infusion pump has brought a new dimension to drug infusion technology. First infusion pump is an electrical arrangement called as "power infuser" and designed to give fluid intravenously [4]. General purpose, surgery, neonatal and pressure-controled types and other types specifically produced to fit for the patients' clinical needs are available[5,6]. Infusion pumps with two channels are also available on the market and they are capable of checking the injection of two seperate IV infusion fluids at different rates. Due to busy traffic in the intensive care units, nurses or physicians are usually challenged to monitor and control the intravenous (IV) pumps. In order to overcome this hurdle, we projected a four-phase research study to develop a nurse console that'll monitor and play with the settings of multiple IV pumps from a central location [7,8]. In this paper, we studied Phase I that is simply simulation of the operational principles of an IV pump. The second phase is all about development of a Software that will have a settings and displaying window, which will eventually be interfaced to a single pump. Revision of the software to add networking capability to monitor and control multiple pumps that'll be integrated with a PC will take place in the third Phase. The fourth and final phase will aim to convert the communication of the whole system to wireless.

2 Materials and methods

Software of the system has been prepared using Delphi 5.0 programming language. System software is operated on Windows 2000 operating system. In the control panel demonstrated in figure 1, it is possible to control two separate IV infusion fluids at different injection rates and time periods. The amount of the fluid, its injection rate depending on minute or second, the use of single or double IV infusion fluid are arranged on the computer screen by the physician or nurse.

Infusion Pump Control Page:

1) Under the title "drop conversion", 20 drops of IV infusion fluid corresponds to 1 cc. (1cc=1ml)
2) "Total amount" shows the full capacity of the bottle containing IV infusion fluid in terms of cc.
3) The amount of IV infusion fluid to be injected into the patient (500 mlt, 1lt, 2lt) is determined by the buttons present on the screen. In the section "required amount", is the amount of fluid asked to be given to the patient and is determined in terms of cc [9].
4) The period of IV fluid to be given to the patient is determined in terms of minutes or seconds according to the physicians' demand. When the value of rate Per minute or second is entered into one of the "cc" or "drop" boxes, the rate value of the remaining three boxes is automatically calculated by the computer.

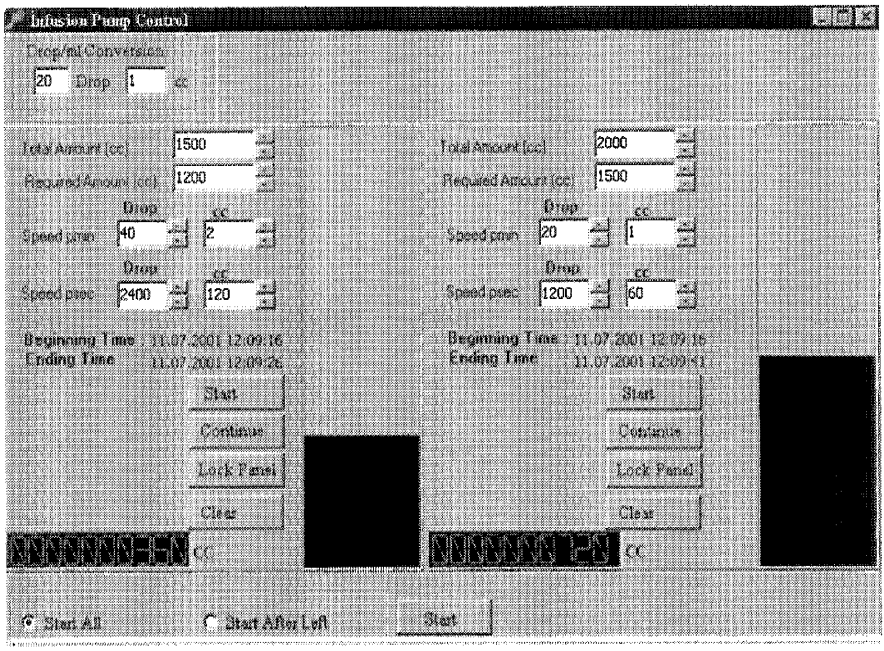

Figure 1: Infusion Pump Control Panel

5) "Beginning time" shows the time when start button is pressed. "Ending time" is calculated automatically depending on the amount entered and rate values.
6) Process can be interrupted by "stop" button, which appears when start button is activated.
7) "Continue button" reactivates the pump after an interruption.
8) The button "Lock Panel" is used for safety purposes. When this button is pressed, other buttons become passive, and programme asks for the code to enter the system. Lock quality of infusion pump resists accidents or deliberate interventions [10,11].
9) All values on the screen are reset by "clear" button.
10) Digital screen shows the amount of IV infusion fluid already given to the patient in terms of cc.
11) The same operations apply for the second panel, too.
12) Two columns located on the right part of the panels help to understand the amount already injected visually.
13) Start all" and "Start after left" options located below the panel can be used to put two pumps into operation simultaneously or one by one [12].

3 Results

Introductory phase software is developed using Delphi 5.0 programming language and this program is to help us understand the working principles of an IV Pump by

simulating its setting controls and displaying. In the case of unavailability of IV Pumps for experimentation purposes, this simulation will take the place of the pump itself and will enable us to work in the office conditions rather than carrying IV pumps over from the University hospital. Volumes and flow rates of multiple fluids to be injected to the patient can be controlled and displayed in separate windows. Monitorization of beginning and ending times, capability of starting and interruption of each fluid injection are all available in our simulation. The lock panel button simulates the password-protected access to the system and protection from deliberate interventions. Especially, digital screen that shows the amount of fluid already given and left in the bottle are very useful for visualization purposes. .

4 Discussions and Conclusion

As it is administered intravenously, IV infusion fluid reaches heart and other organs directly. It is a medical necessity that drugs directly injected into the blood stream should be injected at long periods. The rate of fluid injection is determined by the physician and fluid flow rate might need to be readjusted according to the patient's situation.

Thanks to this four-phase study that infusion regulation control and monitorization could be brought to a more reliable and more sensitive position compared to today's usage of IV pumps. Since it could remove such obligations for the physician and health staff as to attend the patient, count the drops and readjust the device continuously during its operation, it has the potential to not only improve nursing services but also increase the quality of the service given to the patient. In addition, it can prevent excessive flow of fluid, which may lead to excessive pulmonary edema and other complications. Consequently, the patient is prevented from over dosage of drugs.

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