Installation of Networked Point-of-care (POC) Arterial Blood Gas Analyzers

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Abstract

Point-of-care testing is testing activities performed outside the clinical laboratories and it is now increased in number because of rapid turnaround time and prompt patient care. However, when POCT is not linked to LIS/HIS, problems in maintenance, quality control, and billing is raised as an issue. We connected four arterial blood gas analyzers to POC data manger and linked the data manager to LIS server. And we developed two types of observation reporting interface (ORI) on our own to meet the need of clinicians. In emergency room, ORI was designed so that ordering and barcode scanning could make data transfer to LIS server possible. As for other devices, ordering is unnecessary and patient I.D. entry is enough for data transfer. POC data manager installed in clinical laboratory was able to perform instrument maintenance, quality control, problem detection and solving. The networked POCT ABGA system installed in our hospital connects POC devices to LIS/HIS via data manager and makes the data retrieval by computer and real-time monitoring of quality control results and instrument status possible. Our system could be presented as a model for networked POCT installation in Korea.

Keywords:

Network; Point-of-care-testing (POCT); Arterial Blood Gas Analyzer; Connectivity

Introduction

Point-of-care-testing (POCT) is defined as testing activities performed outside the physical facilities of the clinical laboratories and requires instruments or kits near the patients rather than dedicated spaces. It is now gaining much popularity because of its rapid turnaround time (TAT) and subsequent prompt patient care. A recent POC survey says 99% of U.S. hospitals have POC devices for glucose monitoring and 69% of them have more than one POC applications installed. However, most of the users are not satisfied with POC devices on the issues of connectivity and data management. Actually 82% of patient test results and 63% of QC results are manually recorded and only about a third of POC test results are currently transferred to the hospital's laboratory information system (LIS) [1].

In Asan Medical Center, a 2,200-beded tertiary hospital in Korea, pregnancy tests, glucose testing, and blood gas and electrolyte tests have been performed outside the clinical laboratory. However, none of them were connected to HIS/LIS so that data retrieval with computer was impossible. Furthermore, unconnected devices made the access of laboratory personnel difficult so that maintenance and quality control of instruments were nearly impossible. As a result, difficulty in data management and impaired reliability of test results were proposed as problems. To overcome these problems, we installed a networked POC blood gas analyzer system with data storage in LIS/HIS and remote maintenance and quality control possible.

Materials and Methods

Blood gas analyzer

pCO_2, pO_2, Ca^{2+}, electrolytes, glucose, and hematocrit with cartridge type reagent. In addition, automatic quality control (QC) and networking support with bi-directional interface are feasible with these devices.

POC Connectivity

Four POC devices, located in emergency room (ER), operation room (OR), pediatric intensive care unit (PICU), and medical intensive care unit (MICU) were interfaced with POC data manager by means of vendor-supplied device interface. And Observation reporting interface (ORI), connecting POC data manager to HIS/LIS, was developed on in-house with Visual Basic and Visual C^{++} program (Microsoft Corporation, One Microsoft Way, Redmond, WA, USA) (Figure 1).

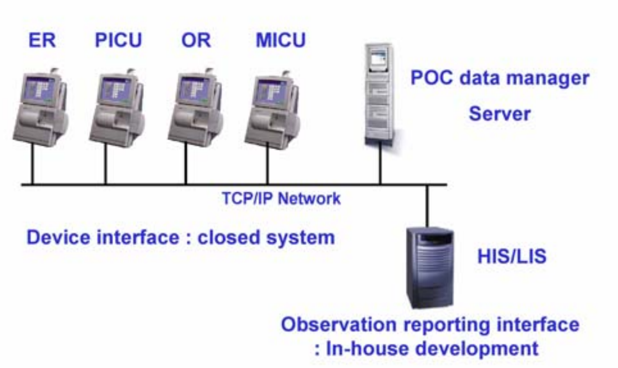

Figure 1. A diagram of networked POC arterial blood gas analyzer and connecting system

Results

Testing Procedures

Testing procedure of the POC device in ER is as follows. After order entry into HIS, barcode is issued first, then after specimen infusion into POC analyzer, barcode is scanned and 'work number generation and result input into LIS' is automatically performed (Figure 2.).

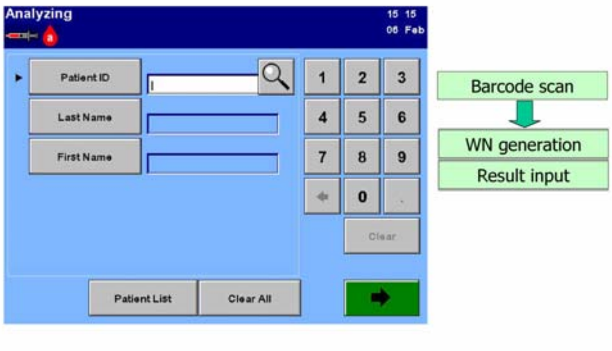

Figure 2. Testing procedures of blood gas analysis using specimen barcode

However, in ICUs or OR, where order entry and barcode printing is actually difficult, the ORI program was developed so that after patient's I.D. entry, 'Ordering, barcode generation, work number generation, and result input into LIS' procedures are performed automatically (Figure 3.).

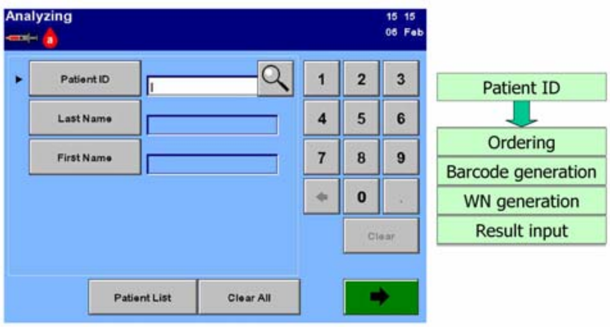

Figure 3. Testing procedures of blood gas analysis using patient I.D. entry

Connectivity to LIS/HIS

Blood gas test results are entered into laboratory information system though the interfaces using either specimen barcode or patient I.D., then the results are managed in the same way as test results performed in clinical laboratory and can be retrieved in HIS (Figure 4.).

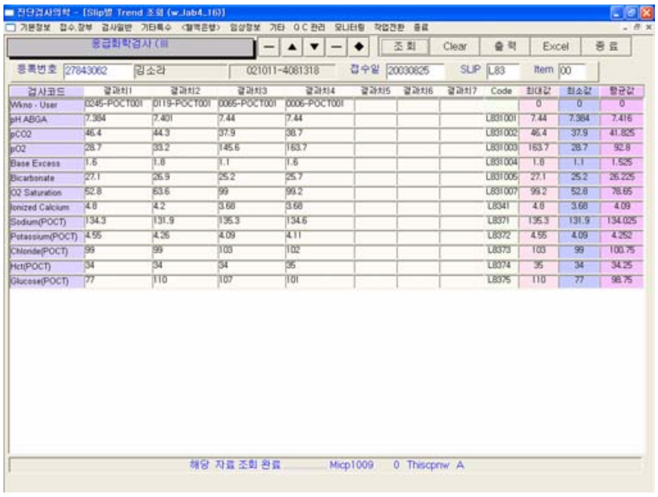

Figure 4. An LIS screen showing the blood gas test results of one patient performed by POC blood gas analyzer

Functions of POC data manager

POC data manager was installed in the department of laboratory medicine to monitor POC devices in testing sites outside the clinical laboratory. The data manager has three functions; that is, instrument maintenance, quality control, and problem detection and solving. For instrument maintenance, data manager can determine the maintenance schedule and check if the maintenance procedures were performed correctly. In addition, it can show overall maintenance schedule and procedures for some period. The methods and time schedule of quality control can be predefined in the data manager and the quality control results and statistics can be retrieved in the data manager. The data manager also shows the Levey-Jennings chart for each test item. The data manager shows the status of each instrument, and when some problems occur in a POC device, the data manager displays an error sign. Furthermore, in addition to visual display, audible alarm rings to alert laboratorians.

Point-of-care testing (POCT) is testing activities outside the physical facilities of the clinical laboratories and they are usually performed beside patients. And they have advantage of shortened turn around time (TAT) and subsequent immediate or almost immediate decision making and rapid response to critical values. In addition, in neonatal and pediatric patients, small amount of specimen is necessary for testing and blood loss could be minimized. All of these benefits could lead to patient satisfaction. With a lot of merits of point-of-care testing, various test items have been developed such as blood glucose tests, arterial blood gas tests, coagulation tests, urinalysis, chemistry tests, complete blood counts *etc* and the market share of POCT is increasing now. A recent survey in Korea says, in 2002, the market share of POCT in all the diagnostics was 17.8%, compared with those of year 2000 and 2001; 13.6% in 2000 and 16.7% in 2001, respectively [2].

However, POCT has a lot of problems now. A recent survey in the United States says only about a third of test results performed by POC devices are transferred to LIS/HIS [1]. Test results not recorded in LIS/HIS can lead to difficulty in data retrieval and missing in billing, both of them could bring about medical and financial loss. In addition, personnel performing POCT are not laboratory technicians and they are not trained for quality control and instrument maintenance. Therefore, without proper monitoring of instruments, the reliability of test results could be challenged.

Connection of POC devices to information system is one of a solution to solve these problems. As to the matter of connectivity, National Committee for Clinical Laboratory Standards (NCCLS) offers POCT-1A as a guideline. This documents provides the framework for engineers to design devices, work stations, and interfaces that allow multiple types and brands of point-of-care devices to communicate bi-directionally with access points, data managers, and laboratory information systems from a variety of vendors. Two steps of interfaces are necessary to connect POC devices to LIS/HIS. One is device interface, which connect the analyzers in POC site to the POC data manager and transfer the test results performed by POC devices to data manager and exchange the QC/QI information between them. The other is observation reporting interface (ORI), which connects POC data manager and LIS server and transfer the test order information from LIS server to POC data manager and test result from POC data manager to LIS server.

Although POCT-1A defines the protocols for POC connectivity, actually no vendor system satisfies all of them. So we used the device interface provided by Bayer Corporation, the manufacturer of our devices and we developed our own ORI. ORI was applied in two ways. In emergency room, an ordering clerk always stays there and many patients are coming in and out all the time. So conventional ordering and barcode issuing was preferred by clinicians. As a result, ORI was designed to make ordering and barcode issuing necessary. After specimen infusion and testing procedure, if barcode is scanned, work number is generated and test results are entered into LIS automatically. In contrast, in case of ICU and OR, barcode scanning was not preferred by clinicians, therefore ORI was programmed so that ordering and specimen barcode are not necessary. After sample infusion and testing procedure, the patient I.D. is entered into POC device, then 'ordering, barcode generation, work number generation, and test results entry into LIS' are automatically performed.

The networked POCT ABGA system installed in our hospital connects POC devices to LIS/HIS and enables the clinicians to retrieve test results by computer system and prevents miss in billing processes. In addition, real-time monitoring of the instrument status and quality control results is possible in the clinical laboratory so that immediate problem detection and solving is possible. Our system could be a prototype for the installation of networked POCT devices in Korean hospitals.

References

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