

Connectivity for Point-of-Care Glucose Testing Reduces Error and Increases Compliance

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Point-of-care testing (POCT) is a rapidly growing field that emphasizes timely results, adherence to regulatory guidelines, as well as reducing cost. Recently, the authors implemented POCT connectivity using the Remote Automated Laboratory System (RALS Plus), which linked 61 glucose testing sites, 120 glucose meters, and 2,686 operators to a data management system. Also, the glucose meter was changed from the Accu-Data GTS to the Accu-Chek Inform. To determine the impact of connectivity on the glucose POCT program, software features such as operator lockout, quality control lockout, and the labor cost for the POCT coordinator were evaluated for a period of 3 months before and after its implementation. Operator and quality control lockout decreased nursing labor costs by \$45.44 every 3 months and POCT coordinator labor costs by \$760.89 every 3 months. RALS Plus software reduced the labor cost of managing the Inform database. The POCT coordinator's labor cost to download updated data manually from the laptop to the Accu-Data GTS was reduced by \$1,043.79. RALS Plus was interfaced bidirectionally with the hospital information system. When the Inform database is docked in the base unit, the results download automatically using an infrared sensor to the hospital information system, thus reducing clerical errors associated with manual result entry and labor costs to nursing by \$32,627.90 every 3 months and to the POCT coordinator by \$468.24 every 3 months. In conclusion, POC connectivity reduces user error, increases program compliance, and decreases POCT coordinator and nursing costs. POC connectivity resulted in a total annual cost savings of \$119,095.00.

Key Words: Connectivity—Operator lockout—Quality control lockout—Compliance—Error reduction.

Introduction

The primary objective of any point-of-care testing (POCT) is to enhance the quality of patient care by improving turnaround time and patient outcome.^{1,2}

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Errors in POCT may be attributable to three types of error.^{1–3} Preanalytic errors occur before specimen testing on the POCT device. Analytic errors include any mishaps during specimen analysis and the production of a result. Postanalytic errors occur while the results are recorded or transcribed into the patient's file or entered into the electronic record. POC connectivity eliminates the manual task of entering the patient results into the hospital information system

(HIS) and potentially eliminates that source of post-analytic error.⁴ The connectivity feature of a bidirectional interface between the glucose device, a data management system (DMS), and the HIS facilitates rapid result reporting.⁵ As most POCT coordinators know, the task of getting the medical or nursing staff to document the POCT result in the HIS is the most challenging.⁶ The implementation of connectivity eliminates manual result documentation by the nursing team, and the manual audits to be performed by the POCT team. Connectivity also captures all financial aspects of POCT as well as ensures the incorporation of the results into the patient's electronic record.⁴ We studied the effect of implementing the Remote Automated Laboratory System (RALS Plus Version 1.2; Medical Automation Systems, Inc., Charlottesville, VA, USA), which linked 61 glucose testing sites, 120 glucose meters, and 2,686 operators to a DMS on errors, compliance, and costs of operation. This implementation occurred concurrently with the conversion of the glucose meter from the Accu-Data GTS to Accu-Chek Inform (Roche, Indianapolis, IN).

Methods

The institution converted from the Accu-Data GTS to Accu-Chek Inform in September 2001. At that time, the Inform meter was interfaced with the RALS Plus and the DMS. The Inform is docked in a base unit, which acts as a battery recharger and source for bidirectional communication. This communication includes the capture of glucose test results into the DMS, (later into the HIS) and the upload into the Inform meter of new operators, reagent edits, or changes to quality control (QC) specifications. RALS Plus was implemented in October 2001 and it was later interfaced with the HIS in August 2002. RALS Plus provides remote access to all glucose meters, thus connecting testing sites with the POCT coordinator. Data were gathered to determine the effect of connectivity on nursing labor cost, POCT coordinator labor cost, user compliance, and reduction of postanalytic errors. The outcome was studied for the 61 nursing units and the POCT coordinator for a period of 3 months. This study was limited to the factors described in the following sections.

Operator Lockout

The operator lockout function fulfills accreditation guidelines and ensures that only fully trained operators may operate the Inform.⁷ The DMS maintains a list of all authorized operators, their certification date, and the date of certification expiration. Any edits or additions are made within minutes and are uploaded to the Inform as soon as the meter is docked in the base unit. The labor costs for both the POCT coordinator and nursing were studied before and after RALS Plus implementation.

Quality Control Lockout

QC lockout prevents operators from using the Inform for patient testing when QC is not performed with specific time intervals or when QC is out of the acceptable range. This feature also fulfills an accreditation guideline.⁸ Connectivity permits the POCT coordinator to tailor the glucose meter QC frequencies for each nursing unit. The POCT coordinator has access to the Inform's memory once it downloads through the RALS Plus remote link to the DMS. At the DMS, QC for each respective glucose meter may be reviewed, and then any recommendations by the POCT coordinator may be transmitted via phone.

Database Management

Before the implementation of connectivity, database maintenance required various manual tasks and consequent labor costs. The Accu-Data GTS would lock out the operator when the meter was at a memory capacity of 1,000 results. This limited memory capacity required manual downloading to a laptop for each meter at scheduled intervals and immediate downloading for meters at memory capacity, reagent edits, the addition of new reagent lot numbers, and daylight savings time.⁹ The Accu-Chek Inform has a memory capacity of 4,000 results, and these results download automatically when the meter is docked in the base unit. The Inform may also be programmed by the POCT coordinator at the DMS to delete results at a specific time interval.

Interface-Related Expenses

The job of entering the glucose results into the patient's electronic record is subject to human error, is time-consuming and is labor intensive. To determine the time required to enter POC glucose results in the

HIS manually, the average time required for 50 nurses working in a total of four different nursing units to complete this task was calculated to be 1 minute (range, 30 seconds–5 minutes). With the connectivity system interfaced to the HIS, the glucose results download automatically, eliminating the time the nursing staff spend typing the result manually into the HIS. Connectivity captures the number of glucose results that are not entered into the patient’s electronic record and thus never billed.¹⁰ Connectivity also reduces the POCT coordinator labor costs associated with performing manual audits on glucose results. The interface cannot eliminate the errors that are made by an operator who types into the Inform the wrong patient identification number (ID no.). This glucose result will not download to the HIS. These results associated with an invalid patient ID no. are filed in a menu option called the “flagged results” in the RALS Plus. Using a bar-coded patient wristband, which may be scanned by the Inform glucose meter, would eliminate these errors associated with manual entry of the wrong patient ID no.¹¹ Once this wristband scanning capability is fully functional, the labor cost currently spent by the POCT coordinator resolving invalid patient ID nos. will be eliminated. A result may fall into the flagged result bay for other reasons, such as a delay in patient registration, if the testing occurs in an area other than the one in which the patient is registered, or if the result is flagged because of meter problems at the time of testing. Another issue of concern related to POC connectivity is the patient with no patient ID no. for a period of time, usually patients in the emergency room or the newborn nursery. This problem may be overcome by formatting the meters used in the previously mentioned patient care areas to accept alpha characters. The operator may enter the patient’s name and, once an ID no. has been issued, the POCT coordinator is contacted to edit the patient ID information and download the glucose result into the HIS.

Results

Table 1 summarizes the savings in labor costs associated with providing POC glucose testing before and after connectivity. For example, POC connectivity eliminated unauthorized operators from using the Inform. Consequently, the POCT coordinator no

Table 1 Cost savings associated with using the RALS Plus connectivity package for a 3-month period

Expenses	Before Connectivity	After Connectivity
Unauthorized operator	\$847.80	0
Quality control	\$58.53	\$4.88
Memory capacity—related downloads	\$29.27	0
Scheduled downloads	\$819.42	0
Adding new reagents	\$117.06	0
Adjusting meter times during daylight savings time	\$78.04	0
Manually entering results into the HIS	\$32,627.90	0
Performing manual audits	\$468.24	0
Monitoring the downloading, status/downloading	0	\$1,755.90
Managing flagged results	0	\$3,511.80
Grand total	\$35,046.26	\$5,272.58

Connectivity-related cost savings, \$29,773.68 every 3 months.
HIS, hospital information system.

longer had to investigate the operator lists for invalid operators, and POCT coordinator labor costs were reduced by \$702.36 every 3 months because they no longer had to counsel staff to use the glucose meters only after proper training. Nursing labor costs were cut by \$145.44 every 3 months. Before connectivity, the number of unauthorized operators was 240 for the 3-month period evaluated, which was reduced to zero after operator lockout was introduced in October 2001. The QC lockout functionality of the RALS Plus system provides the QC results at the DMS for the POCT coordinator to review. Problem resolution over the phone rather than a visit to the nursing station reduced POCT coordinator labor costs from \$58.53 every 3 months to \$4.88 every 3 months.

Managing the Accu-Data GTS database required the POCT coordinator to perform many lengthy manual tasks. For example, downloading meters manually that were at the full memory capacity of 1,000 results to a laptop computer cost \$29.27 every 3 months. Also, the POCT coordinator had to perform scheduled monthly downloads of data to the laptop computer to monitor glucose meter operation, QC results, and the number of unauthorized users.¹² These activities cost \$819.42 every 3 months. The manual data download to a laptop computer was required for every glucose meter to add new reagent lot numbers (labor cost of \$117.06 every 3 months) and

to adjust times for daylight savings (labor cost of \$78.04 every 3 months). The interface of RALS Plus to the HIS facilitated the automatic distribution of glucose results into the patient's electronic record and initiated a bill. Before connectivity, the nursing team would spend an average of 1 minute to enter each glucose result into the HIS. This labor cost of \$32,627.90 every 3 months was eliminated after the RALS Plus–HIS interface was completed. Auditing patient records manually to ensure that the glucose results were in the record cost \$468.24 every 3 months before RALS Plus. The RALS Plus system introduced some daily tasks. Every glucose meter has its own base unit, which is connected to a data port for connecting the Inform to the DMS and finally to the HIS. The status and time interval for data transfer of every site for data downloading must be checked daily. This daily activity generates POCT coordinator labor costs of \$1,755.90 every 3 months. Flagged or rejected results may occur if there is an error in manually entering the patient ID no., the wrong operator ID no. if operator lockout is not enabled, or other failures. Resolving the status of these flagged results may take as long as 2 hours daily, which results in labor costs of \$3,511.80 every 3 months.

Discussion

POCT DMSs are available from several vendors.⁶ The features and functionality of each of these systems need to be evaluated carefully before the decision to purchase is made. Many of these software products, including the RALS Plus system, may be modified to conform with institutional POCT policies. After the introduction of POCT connectivity software, the data presented here reveal that the greatest cost savings is achieved by eliminating the time required for the nursing staff to enter the glucose result manually into the HIS at the nursing station (see Table 1). Other cost saving features include operator lockout and transmitting updates for new reagent and QC lot numbers, QC ranges, and adjusting all glucose meters to daylight savings time through the bidirectional interface from the central DMS. The total amount in cost savings of \$119,095.00 would yield a return on investment within 14 months for the glucose program alone. Additional POCT programs will be interfaced in the future.

The POCT device may be interfaced to the laboratory information system–HIS using two different approaches: scripted interface or bidirectional interface.¹⁰ Screen scraping or a scripted interface transmits elements required to complete the steps in test ordering and result placement in the patient's record by removing or scraping data from defined locations on various data screens. This type of interface is easy to complete, but has the inherent error of transmitting incorrect data from the screen location, if the screen has been reorganized and the interface is not updated. A bidirectional interface between the POCT device and DMS requires more time, but is not affected by screen geographic location of information. With both types of interfaces the results are checked after they reach the laboratory information system–HIS. If the patient's ID no. is incorrect, the test result will be retained in the DMS for review and resolution by the POCT coordinator (see Table 1). The object is to limit the number of flagged results to a minimum, thus reducing the time required by the POCT coordinator to determine the source of error. Patient ID no. errors would be reduced if each patient had a bar-coded wristband,¹¹ which could be read by the infrared sensor on the end of the Inform glucose meter.

The subject of POC connectivity is relatively new and still requires some standardization between the different vendors. The Connectivity Industrial Consortium was formed in early 2000 to tackle POCT connectivity and to develop standards between POC instruments and connectivity systems.^{3,4} In 2001, the National Committee for Clinical Laboratory Standards published industry standards for POC connectivity.¹² POCT results account for only 0 to 5% of the total number of laboratory transactions in the HIS, and only a small fraction of laboratories have POCT support provided by this laboratory information system vendor.¹³

Conclusion

Connectivity provides a positive benefit for a POCT glucose testing program. Implementation of the RALS Plus system increased operator compliance with regulatory guidelines. Second, it achieved cost savings for the POCT coordinator and the nursing

team. Operator compliance was enhanced by the operator lockout and QC lockout functions. Using the bidirectional interface between the DMS and glucose meters, the POCT coordinator may change or enter new data at the DMS to be downloaded to all the glucose meters without having to leave the office. The interface between RALS Plus and the HIS reduced nursing tasks and POCT coordinator tasks related to manual results entry. There are unavoidable labor expenses associated with the maintenance of the RALS Plus software. The use of bar-coded patient wristbands that may be scanned by the Inform glucose meter will eliminate the labor costs related to resolving the flagged results associated with incorrect patient ID nos.

Therefore, connectivity reduces labor costs attributable to reduced manual procedural steps including elimination of manual glucose result entry and the evaluation of unauthorized operators. POC connectivity resulted in a total cost saving of \$29,773.68 over a period of 3 months or \$119,095.00 per year. The connectivity solution will also facilitate data collection and analysis for noninvasive or minimally invasive continuous glucose monitoring devices.¹⁴

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