POCT data mining – an introduction

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Point-of-care testing (POCT) results, like other forms of laboratory data, hold potential hidden information that can be utilized to improve patient care.

The technique of extracting useful information from vast amounts of data is termed "*data mining*". Technological solutions are now available to meet the challenges of data collection, data management, data integration and accessibility.

While data mining can convert data into information, in the future real-time communication could allow faster data analysis to improve patient care at the bedside.

Point-of-care testing (POCT) results, like other forms of laboratory data, hold potential for revealing hidden information that can be utilized to improve patient care. Unfortunately, POCT results are not readily available in a single database.

POCT is performed in multiple locations, often by manual, visually interpreted dipsticks and proprietary devices that do not readily interconnect, so POCT data is scattered in different places and in different databases that often do not communicate with each other.

An institution, for instance, might visually read urine dipsticks, pregnancy tests, HgbA1c, pH and occult blood tests, the results of which are manually transcribed into a hospital information system, while devices like glucose meters and blood gas instruments report directly into a laboratory information system.

Outpatient POCT may be kept in the physician's office, separate from either the hospital or laboratory information systems.

To analyze, sort and mine laboratory data, all of the test results must be brought together in a common database,

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or the various computer systems must communicate with each other to allow the combining of data from different systems.

For POCT, combining data is challenging because of the sheer number of different manufacturers, models of devices and distance between testing locations.

Newer POCT devices have computerized data management features that store pertinent data on the device in conjunction with the test result; like date, time, patient identification, operator identification, device serial number, reagent and control lots, expiration dates, control results and specimen comments.

Manufacturers have developed computer systems and software that allow the automatic downloading of POCT device data into a database and transferring of the data electronically to LIS or HIS for billing and permanent documentation.

Historically, POCT devices and computer systems have required proprietary cabling, connectors and communication protocols to transfer data from devices to more permanent information systems.

This meant that data from one device could not be combined with data from a different manufacturer, and even different models of devices from the same manufacturer might not utilize the same cabling and computer systems.

This required institutions to buy different computer systems and possibly rewire their facilities when implementing different POCT devices.

Communication standardization and "*middleware*"

Several recent developments in the standardization of device communication and middleware have eased the task of collecting POCT data in one place.

Early in 2000, a consortium of POCT vendors developed a universal communication protocol for POCT devices (POCT-1A) that was transferred to the Clinical and Laboratory Standards Institute (formerly NCCLS) for promotion and standards maintenance [1].

The POCT-1A standard defined for the first time a common protocol for communicating POCT data from devices to computer systems, so that data from different manufacturers could be collected in the same database.

Middleware is the computer technology (hardware and software) that can help integrate data from different sources as well as provide manipulations of data, including data-mining algorithms.

Middleware is a type of "*data manager*", as POCT computers are termed, but middleware has the flexibility to allow the consumer to customize the way they view and handle the data.

Older data management systems required export of data to separate programs for customers to manage data, or required the manufacturer to create a data report and to develop the equations to combine data, calculate statistics, and even display plots of data and statistics.

With middleware, consumers can create their own data manipulations as needs change.

The term "*middleware*" has recently taken a wider definition to encompass not just data management computers that handle POCT data, but systems that can communicate with other computers, instruments and databases to integrate and combine data from many different sources.

Before POCT-1A, each vendor had their own proprietary "*data managers*", but the POCT-1A standard promotes the development of universal systems where different devices can connect and communicate their data to a single database.

Data management algorithms can be written and implemented by consumers of the middleware system without waiting for the computer vendor to develop the equations in a future upgrade at additional cost.

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Data manipulation is thus easier to implement and more cost effective through a middleware computer than through the traditional laboratory or hospital information systems.

The AACC has even created a middleware library of mathematical algorithms to assist institutions that are experimenting with data-mining equations, reflex testing and auto-verification [2].

For POCT, middleware computers are the next generation of manufacturer-based data managers that offer greater flexibility of data management and the ability to more readily connect a wider menu of devices.

Integration provides simplification

Integration of data into a single database or middleware computer has several advantages that are fundamental steps towards data mining. The use of a single database simplifies the interaction of staff with the data.

There is one interface with common features for staff to access and manipulate data. Staff do not need to learn different programming features for each vendor's device, but can learn one, shared system to access all data in a standard fashion.

Use of a single database allows data manipulations more efficiently and faster than communicating sets of data between separate databases. Use of a single system also standardizes the data management processes and final reports that can be generated.

Web portals

The Internet has further improved our ability to collect POCT data from remote locations. Internet connections are becoming universal and its use makes it easy to transfer POCT data from remote sites to a single, central database without the expense and labor of additional wiring or proprietary device and computer connections. Additionally, most computers with Internet connections have standard web-browser software already available.

The use of web portals, to access and view data over secure web browsers, allows easier access to data without the expense of additional software, computers, training and problems with software incompatibility.

In our health system, physicians can access their patient's electronic medical record, order medications and view radiology or lab results from any computer by accessing a web page on their browser and signing into the secure site with a password.

We similarly transfer POCT data from devices throughout Western Massachusetts over the Internet to a single server in our laboratory for manipulation, sorting and viewing data by anyone who has access to our site over their web browser.

Error prevention better than cure

In the future, the application of POCT data management will certainly be more varied and sophisticated. One of the current limitations of POCT is the immediacy of the result and the delay in acquiring the data from devices.

Currently, POCT devices require an operator to manually download the data to a computer, so data collection is intermittent and not continuous. POCT results are generated at the patient's bedside and medical treatment often instituted before the test results are communicated. Once real-time wireless communication becomes available, the door will open to a new level of data management possibilities.

Real-time communication of POCT devices allows the detection of errors as they occur, rather than retrospectively after data have been downloaded and processed. As operators enter a patient identification, that number is checked and verified against an active patient record.

Some models of blood gas analyzers already use this method today.

Real-time error detection could even be used by the device to control access to testing features. This would

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prevent errors from occurring as opposed to correcting the errors after the test is completed.

The ability to combine patient information in real-time allows the prediction and warning of problems before patient care is affected. Current glucose meters are limited to a range of patient hematocrit; however, few clinicians verify the patient's actual hematocrit before commencing testing.

If glucose meters were capable of verifying the patient's hematocrit after the operator has entered the patient's identification, a warning could be returned on the device if the patient's hematocrit is out of range, before the test is conducted and treatment is based on an incorrect result.

Communication of POCT devices with a pharmacy database could also return a warning of potential drug interferences with the method. Drug and dosage information would further be important to the interpretation of the test result.

For instance, the information that a patient is currently taking coumadin or heparin could flag the POCT prothrombin or activated partial thromboplastin result, and attach the reference range appropriate for the patient's dose.

Drug information linked to laboratory trends could further be utilized to calculate an individual patient's response to therapy and predict future dosage.

Imagine if a patient's past insulin dose and glucose response were available at the time a pre-meal glucose were being performed, and the glucose meter were not only able to give the patient's current glucose level but also estimate the patient's required insulin dose based on their past response.

Calculation automation

Combinations of data could be utilized to provide calculated parameters for patient care. Examples include the calculated glomerular filtration rate as an estimate of renal function provided the patient's age, sex and weight or race are available to combine with the patient's serum creatinine level.

Hemodynamic and oxygenation parameters could be calculated for use by the critical care intensivist provided that the patient's blood gases are available and can be combined with the hemoglobin, fraction of inspired oxygen, body surface area and other physiologic parameters.

Physicians currently calculate these estimates manually, but if the data can be combined in real-time and displayed with the POCT result, patient care would be streamlined and there would be less chance of a calculation error.

Summary

Data mining is a technique for combining, sorting and manipulating data to extract useful information. Integration of data is a prerequisite step to data mining.

This can be accomplished by collecting all laboratory results in a common database or establishing communication between the various databases and other sources of data.

For core laboratories, instrument interfaces communicate data to laboratory and hospital information systems, but for POCT there are multiple devices, vendors and numerous testing locations.

Use of a data management system or middleware computer that can collect data from multiple devices and channel the data through a single interface to the laboratory or hospital information system facilitates the combining and centralization of laboratory and POCT data.

The development of the NCCLS POCT-1A standard has simplified our ability to connect and collect data from multiple types of devices and vendors.

Integration makes possible the manipulation, sorting and mathematical combination of POCT data, as well

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as combining this data with other databases such as core laboratory results, the patient's electronic medical record, pharmacy, radiology and outpatient records.

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