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Technical Note

Streamlined sign-out of capillary protein electrophoresis using middleware and an open-source macro application

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Abstract

Background: Interfacing of clinical laboratory instruments with the laboratory information system (LIS) via "middleware" software is increasingly common. Our clinical laboratory implemented capillary electrophoresis using a Sebia® Capillarys-2™ (Norcross, GA, USA) instrument for serum and urine protein electrophoresis. Using Data Innovations Instrument Manager, an interface was established with the LIS (Cerner) that allowed for bi-directional transmission of numeric data. However, the text of the interpretive pathology report was not properly transferred. To reduce manual effort and possibility for error in text data transfer, we developed scripts in AutoHotkey, a free, open-source macro-creation and automation software utility. **Materials and Methods:** Scripts were written to create macros that automated mouse and key strokes. The scripts retrieve the specimen accession number, capture user input text, and insert the text interpretation in the correct patient record in the desired format. **Results:** The scripts accurately and precisely transfer narrative interpretation into the LIS. Combined with bar-code reading by the electrophoresis instrument, the scripts transfer data efficiently to the correct patient record. In addition, the AutoHotKey script automated repetitive key strokes required for manual entry into the LIS, making protein electrophoresis sign-out easier to learn and faster to use by the pathology residents. Scripts allow for either preliminary verification by residents or final sign-out by the attending pathologist. **Conclusions:** Using the open-source AutoHotKey software, we successfully improved the transfer of text data between capillary electrophoresis software and the LIS. The use of open-source software tools should not be overlooked as tools to improve interfacing of laboratory instruments.

Key words: Capillary electrophoresis, instrumentation, laboratory information system, middleware, open-source software

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INTRODUCTION

Clinical laboratories are a key component of modern health care.[1] Modern laboratories are equipped with increasing number of sophisticated instruments, which provide precise and accurate diagnostic information and help physicians make correct clinical decisions.[2] For proper workflow in the laboratory, interfacing of clinical laboratory instruments with the laboratory information system (LIS) via "middleware" software is increasingly common.[3] Some instruments come with vendor supported middleware, but most of the time a third party middleware facilitates this interfacing.[4,5]

Background

The core clinical laboratory at University of Iowa Hospitals and Clinics replaced gel electrophoresis and implemented capillary electrophoresis using a Sebia® Capillarys-2™ (Norcross, GA, USA) instrument for serum and urine protein electrophoresis. University of Iowa Hospitals and Clinics is a quaternary care academic medical center which includes a multiple myeloma treatment service. Our laboratory performed 3250 serum protein electrophoresis (SPE), 2548 serum immunofixation electrophoresis (SIFE), 528 urine protein electrophoresis, Twenty four hour (UPET), 188 urine protein electrophoresis, random specimen (UPE) and 886 urine immunofixation electrophoresis (UIFE) during 2012-2014. Our laboratory utilizes Data Innovations Instrument Manager (South Burlington, Vermont, USA) as a middleware to establish communication between most of our instrument and Cerner Laboratory Information System (Kansas City, MO, USA).[6] This same middleware was used for data transfer between Sebia® Capillarys-2™ instrument and Cerner LIS. The interface after initial troubleshooting successfully allowed bi-directional transmission of numeric data, that is, the total protein value and its fractions. However, the text of the interpretive pathology report was not properly transferred. The incompatibility between instrument, middleware and LIS resulted in losing the text formatting during the transfer [Figure 1]. This resulted in manual re-entry of interpretive text and made the system prone to copy-paste errors.[7,8]

MATERIALS AND METHODS

After exploring options for this trivial appearing problem, we evaluated AutoHotkey (http://www.autohotkey.com), a free, open-source macro-creation and automation software utility.[9] Scripts were written in AutoHotkey to create macros that automated mouse and key strokes (script included in the supporting material). The scripts retrieve the specimen accession number, capture user input text, and insert the text interpretation in the correct patient record in the desired format [Figure 2].

AutoHotkey was also used to create abbreviations for various interpretation templates [Table 1]. These keystrokes which are sent in response to typed abbreviations are known as "hotstrings."[9] In addition, AutoHotkey automated repetitive nonintuitive keys strokes which were required for maneuvering through our LIS. Using AutoHotkey, we were able to save a substantial number of nonintuitive keystrokes involved in sign-out [Table 2].

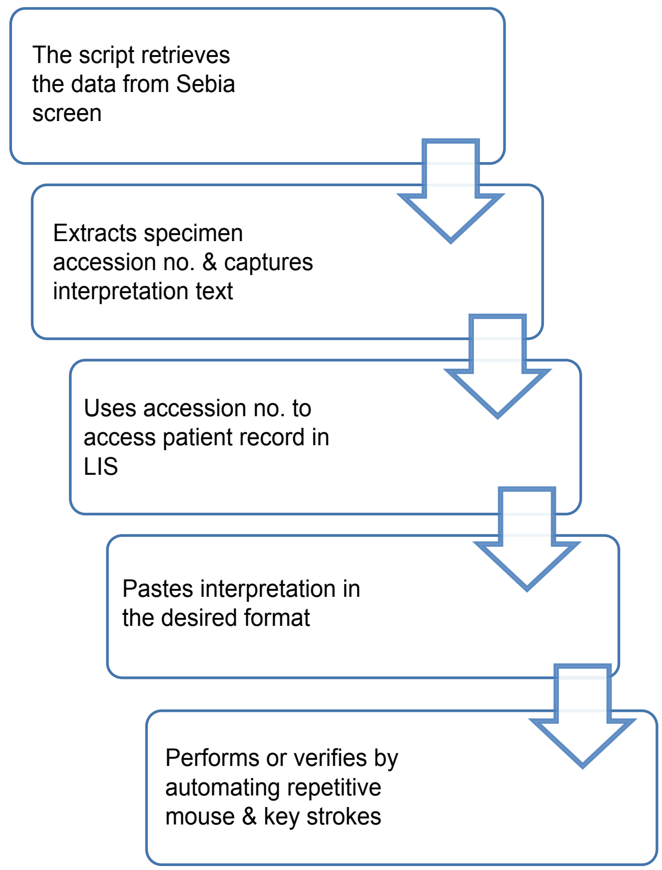

Figure 2: Functions performed by Autohotkey script

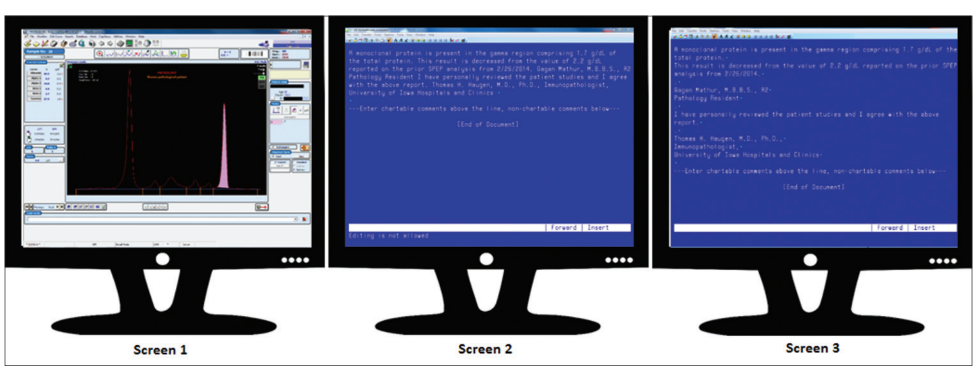

Figure 1: Screen 1 showing Sebia interface, screen 2 showing unformatted transferred interpretation in laboratory information system (LIS) and screen 3 showing formatted interpretation in LIS transferred with the help of AutoHotKeys

Table 1: Hotstrings for templates

Hotstrings for templates	
SIFE	
sik	Immunotyping electrophoresis shows a monoclonal IgG kappa immunoglobulin
sil	Immunotyping electrophoresis shows a monoclonal IgG lambda immunoglobulin
sin	Immunotyping electrophoresis shows no monoclonal immunoglobulins
SPE	
spn	A monoclonal protein is not identified by SPE. The alpha 2 fraction is elevated and may represent increased acute phase reactants. Hypoalbuminemia, hypogammaglobulinemia and hypoproteinemia are also present
spp	A monoclonal protein is present in the gamma region comprising 0.1 g/dL of the total protein. This result is decreased from the value of 0.1 g/dL reported on the prior SPE analysis from 1/1/12. The alpha 2 fraction is elevated and may represent increased acute phase reactants. Hypoalbuminemia, hypogammaglobulinemia and hypoproteinemia are also present
UIFE	
uik	Urine immunotyping electrophoresis shows a monoclonal IgG kappa immunoglobulin. There is no evidence for Bence-Jones proteinuria
uikl	Urine immunotyping electrophoresis shows a kappa free light chain without corresponding heavy chain cross-reactivity. Consistent with Bence-Jones proteinuria
uil	Urine immunotyping electrophoresis shows a monoclonal IgG lambda immunoglobulin. There is no evidence for Bence-Jones proteinuria
uill	Urine immunotyping electrophoresis shows a lambda free light chain without corresponding heavy chain cross-reactivity. Consistent with Bence-Jones proteinuria
uin	Urine immunotyping electrophoresis shows no restricted bands. There is no evidence of Bence-Jones proteinuria
UPE	
upe	A monoclonal protein is not identified by urine protein electrophoresis. The specimen is a random urine
upep	A monoclonal protein is present in the gamma region, comprising 55 mg/dL of the total protein. This specimen is a random urine
UPET	
upet	A monoclonal protein is not identified by urine protein electrophoresis. The specimen is a 24-h urine
upetp	A monoclonal protein is present in the gamma region, comprising 55 mg/dL of the total protein. Based on the 24-h total protein, this represents excretion of 0.50 g/day. The specimen is a 24-h urine

SIFE: Serum immunofixation electrophoresis, SPE: Serum protein electrophoresis, UIFE: Urine immunofixation electrophoresis

Table 2: Key strokes to sign-out electrophoresis and number of keystrokes saved

Key strokes to sign-out electrophoresis		
Key stroke	**Function**	**Number of key strokes saved**
Windows a	Copy narrative tagged with accession number to LIS	24-32
Windows b	Perform a test-resident	15
Windows c	Verify the test-attending	8

LIS: Laboratory information system

RESULTS

The Autohotkey scripts executed well and accurately transferred narrative interpretation into the LIS in desired text formatting [Figure 1], thus reducing the manual effort of reentering the interpretation and also decreased the possibility for error in text data transfer. The scripts were basically executing copy-paste in an automated way. An important additional feature was that the script acquired both the accession number and the specimen type (e.g. SPE and SIFE for serums and UPE, UPET and UIFE for urines) from the Sebia instrument. Using the accession number and the specimen type, the script opened the patient's record for this specimen in the LIS. This step ensured that the narrative was inserted into the correct patient record and type. Errors in patient and sample identification are minimized. The result was smooth and efficient transfer of data in the correct patient record.

The Autohotkey scripts were easy and intuitive to learn by users. Executing the script for transferring the text data included just two simple key strokes [Table 2], thus facilitating ease of adoption by pathology residents who rotated through the clinical chemistry service. Scripts allow for either preliminary verification by residents or final sign-out by the attending pathologist [Figure 3]. Finally, the scripts promoted a nearly paperless process for data entry into the electronic record.

CONCLUSIONS

Using the open-source AutoHotKey software, we successfully improved the transfer of text data between capillary electrophoresis software and the LIS. Open-source software allows the end user to review, modify, or share the source code, blueprint or design

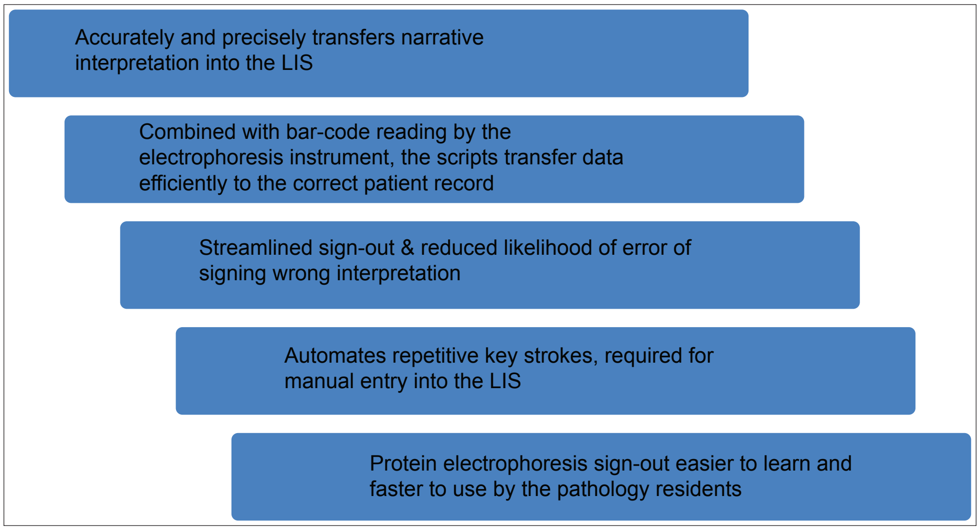

Figure 3: Result of Autohotkry script execution

of the software for their own needs, customization, curiosity or troubleshooting under defined terms and conditions.[10] Open-source software are often free or available at low cost. Although open-source software have been successfully used in many fields of medicine like imaging, electronic medical records, electronic health records, public health and bio surveillance, research, etc.,[11] but there is no published data on use of open-source software for interfacing clinical laboratory instruments with the LIS or middleware. Proper interfacing of complex laboratory instruments often requires sophisticated middleware software, but compatibility issues arise from time to time and hinder smooth functioning of an automated laboratory. Open-source software tools should not be overlooked as tools to improve interfacing of laboratory instruments.

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