



# WHITE PAPER

## Laboratory Interoperability Best Practices

Ten Mistakes to Avoid

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A brief guide to understanding  
common issues with laboratory  
interfacing

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## EXECUTIVE SUMMARY

With the advent of the Centers for Medicare & Medicaid Services (CMS) Electronic Health Records (EHR) Incentive Programs to encourage medical providers to move to electronic health records in the physician office setting, the laboratory is faced with an unprecedented need to establish and maintain electronic connections to multiple disparate electronic health records systems. In earlier times, many hospital laboratories could establish one interface, or connection, to the hospital information system and that would suffice. But as more office practices implement EHRs, there is a growing demand for the electronic delivery of laboratory results. According to CMS, as of January 31, 2013, more than 372,000 eligible professionals, eligible hospitals, and critical access hospitals are actively registered in the Medicare and Medicaid EHR Incentive Programs.<sup>1</sup> A number of information technology (IT) challenges exist, including the fact that while there are some applicable IT standards; in reality, they are not “standard” enough to allow “plug and play” interfacing between different software systems. Each provider’s EHR is typically a stand-alone system customized by that particular practice. And, even though you may be able to purchase an interface from your laboratory information system (LIS) vendor to connect to a particular EHR, it is almost guaranteed that some level of further customization will be needed.

There are numerous examples of problems that can occur when interfacing laboratory systems to EHRs. Some of the common ones include:

- Results that are truncated
- Comments that do not display
- Results that are not accepted because the patient identifiers do not match
- Results being mapped to incorrect tests in the display
- Errors that aren’t detected because interface error logs are not monitored

Proper attention to the capabilities and limitations of the systems involved, use of interfacing and data standards, and comprehensive initial and ongoing validation processes will allow laboratories to minimize the number of potentially significant issues they encounter.

For laboratories looking to establish connectivity with EHRs, there are two basic choices: 1) A laboratory can purchase or program a specific interface directly between the LIS and the client EHR. 2) Or a laboratory can use a middleware solution where a third-party vendor becomes the middleman, takes a

### CMS EHR Incentive Program

The Medicare and Medicaid Electronic Health Records (EHR) Incentive Programs will provide incentive payments to eligible professionals and eligible hospitals as they demonstrate adoption, implementation, upgrading, or meaningful use of certified EHR technology. These incentive programs are designed to support providers in this period of Health IT transition and encourage the use of EHRs in meaningful ways to help our nation to improve the quality, safety, and efficiency of patient health care.

single “result feed” from an LIS, and reformats it as needed to feed a variety of client EHRs. (With orders, a middleware solution can perform the reverse transformation, taking diverse order feeds from a variety of client EHRs and reformatting them into a single data stream into the LIS). The preferred solutions will depend greatly upon the local situation. A full exploration of the pros and cons of each solution is beyond the scope of this white paper. (Additional information is provided yearly in *CAP TODAY*'s Laboratory-Provider software survey<sup>2</sup>).

Beyond the technical issues, there are other challenges for the laboratory, including the availability of resources, both capital and personnel, to establish and test interfaces. The process is often complicated by the fact that a laboratory may have to organize the efforts of two or three software vendors, plus networking engineers and clinical staff. When dealing with private medical practices, this is compounded by the fact that they may not have dedicated employees to support their information systems, instead relying on vendors or consultants for their IT needs.

Regardless of the particular mechanism chosen to achieve connectivity, a number of common issues arise in the course of establishing these interfaces. They can be grouped into four broad categories:

1. Data harmonization and standardization

**Mistake #1: Not having standardized test definitions**

**Mistake #2: Having unsynchronized test catalogs**

**Mistake #3: Not uniquely identifying test names using LOINC**

2. Networking

**Mistake #4: Assuming that it will be easy to establish a secure electronic connection**

3. Validation processes

**Mistake #5: Not having a thorough testing plan**

**Mistake #6: Failing to recognize that validation of the EHR result display is an important responsibility**

**Mistake #7: Not recognizing challenges and pitfalls associated with patient identifiers**

4. Report delivery and display

**Mistake #8: Not considering all results delivery situations**

**Mistake #9: Not anticipating that results may be passed through multiple EHRs**

**Mistake #10: Assuming that EHRs can properly display complex reports**

This white paper provides pathologists and laboratory professionals with a concise overview of these 10 common issues to consider when establishing and maintaining laboratory interfaces and suggested approaches to mitigating them. Given the timing requirements of the federal Meaningful Use incentives

and the large number of interfaces that a laboratory may need to establish, it is imperative to anticipate and plan for issues in advance. This will ensure that pathologists and the laboratories they direct can continue to provide the high level of care that patients deserve.

The Diagnostic Intelligence & Health Information Technology (DIHIT) Committee of the College of American Pathologists (CAP) developed this white paper. Members of this committee are practicing pathologists with experience and expertise in pathology informatics. By pooling our experiences, we developed and categorized a wide variety of issues that arise in the course of creating interfaces between laboratory information systems and EHRs. The content of this white paper was created by the authors and then vetted with the DIHIT Committee. The views and recommendations are the opinions of the authors and are not to be construed as official CAP guidelines or recommendations. Any comments or questions can be sent to [informatics@cap.org](mailto:informatics@cap.org).

Glossary and Additional Resources sections are included at the end of this document for references.

## MISTAKE #1: Not having standardized test definitions

In order for systems to be interoperable, there must be a shared understanding of what certain concepts mean. In the laboratory domain, there are many examples related to how tests are defined that emphasize this point. For instance, if a printed report says that the glucose level is 100 mg/dL, and does not give any more information, most clinicians would automatically assume that this was a serum/plasma sample, as opposed to a urine sample or a sample drawn as part of a glucose tolerance test. However, electronic systems don't have this ability to draw inferences; so in order to transmit test results successfully, we need to have a system for ensuring that both the sending and receiving system know how to interpret and file a given result. Another example is a therapeutic drug level, such as gentamicin. If the laboratory system has only a generic definition of a *gentamicin*, but the receiving system has separate results choices for "*gentamicin, peak*," "*gentamicin, trough*" and "*gentamicin, random*," then it is hard to know how to link the tests between the two systems.

There are two parts to addressing this issue successfully. First, the laboratory and the office system need to agree on the catalog of possible tests and ensuing results. This is typically done at the beginning of the interfacing project by comparing the lists of tests (catalogs) that are defined in each system and building any tests that are missing. Each test then needs to be mapped to the corresponding test in the other system. Currently, creating a table that contains a list of the test codes in one system (the LIS) and the matching test code in the other system (the EHR) will do this. In this approach, the mapping needs to be done between your LIS and each test in every EHR that you will interface. An alternative approach uses a standardized code system that uniquely identifies each particular test. If both systems use this coding system, then at least some of the matching can happen automatically. This type of coding system for clinical laboratory does exist; it is called LOINC (Logical Observation Identifiers Names and Codes) and will be more fully described in a later section. In recent times, the LOINC naming system has been identified as a key component of a test definition strategy. The use of LOINC in certain instances will be required to qualify for the "Meaningful Use" incentives under the Health Information Technology for Economic and Clinical Health (HITECH) Act. This is an area that each laboratory will need to become familiar with in order to optimize LIS to EHR functionality. The initial effort to implement LOINC may require significant resources and new tests may need to be defined, but this work can be leveraged when creating future interfaces. Becoming

**Office of the National  
Coordinator for Health IT (ONC)  
Electronic Directory of Services  
(eDOS) Initiative<sup>3</sup>**

The ONC Electronic Directory of Service (eDOS) effort aims to provide an electronic interchange of a laboratory's directory of services in a structured format based on a recent HL7 standard. It will define the format to deliver the laboratory test menu offerings for systems that support the electronic laboratory ordering, results reporting and other functionality. eDOS is expected to be included in Stage 3 of Meaningful Use.

compliant with the federal informatics standardization framework will become imperative by 2014 (Stage 2 Meaningful Use certification).

Many of us are aware that the development and continued maintenance of the test definitions catalog for an individual institution's LIS has been a relatively circumscribed effort over the years. This is because of the isolation of individual hospitals from others, the persistent use of paper-based medical records, and the lack of need to communicate electronically with other hospitals and health systems. However, now with the CMS Meaningful Use Final Rules, readiness to exchange patient data electronically has essentially become a requirement for all hospitals in the US. This initial investment in developing the laboratory definitions and mapping and assigning LOINC codes can amount to substantial commitment of time and effort by staff. Since test definition and coding maintenance will be an ongoing quality activity, we recommend a team approach, going beyond the walls of the individual laboratories consisting of laboratory directors, managers, and LIS and IS staff of the health care institution. We also recommend that clinical laboratory directors and managers make LIS vocabulary and coding maintenance a part of their annual routine of review, similar to reviewing procedure manuals, safety manuals, and HIPAA requirements.

Beyond the requirement for local (LIS to EHR) vocabulary standardization, the Affordable Care Act (ACA) requires the capability to participate in a health information exchange (HIE). Thus, the comments above on intra-institutional preparation for complying with ACA requirements also apply equally at a regional and statewide level. The resources available to help laboratories attain compliance with regional requirements of ACA are the same as those presented above, and the managerial recommendations are similar but are applied on a regional basis.

Management key points	Technical key points
1. Recognize that some test definitions may need to be changed for optimal interfacing.	1. Evaluate the current test definitions to see if they are compatible with LOINC coding.
2. Involve pathologist in decision-making regarding test definitions so that clinical needs are considered.	

## **MISTAKE #2: Having unsynchronized test catalogs**

Now that you have developed a test catalog and definitions and a way to maintain that catalog, a process needs to alert all downstream entities whenever you make a change. Laboratories and medical practices are dynamic entities, and it can be said with some truth that change is constant in these environments. New laboratory tests are introduced monthly; and every time a laboratory offers a new test or a practice wants to order a new test, the test catalog of all interfaced systems needs to be updated. The issue of synchronizing updates to these dictionaries is one that laboratories have struggled with for years, and it will continue to be an issue into the future. Currently, the usual approach to synchronizing the catalogs is to send written or electronic (email) communications with the details of the changes and the effective date to all affected users. This message is critical if a laboratory decides to implement a new test. The laboratory must communicate with all interfaced systems to prepare those systems to be able to receive new results. If a receiving system is not aware of a new result, it may not be able handle the result and may ignore the result, which could have negative impact on patient care.

The laboratory will typically need to set up some sort of manual change tracking system. It should record information about the nature of the change, when each interfaced system manager was notified of the change, and when each system confirmed that the updates were implemented and are ready to receive the new results. Ideally, in the case of a new test, testing would be done in advance of the change being made "live." This testing should evaluate not only whether the result messages arrive at the destination and are processed without error, but also whether the new result is displayed appropriately for the clinician to view.

The laboratory needs to make an important decision on how many tests to specifically define in the LIS. If a test is ordered that is not already built (usually a reference laboratory or "send-out" test), a common workaround involves the laboratory to use a miscellaneous test code—a test that is designed as a placeholder. This enables the laboratory to process the testing and issue a report. However, this test will not be easily found in the EHR, since it will usually have a test name like "miscellaneous reference laboratory test." In addition, the results will not be able to be trended, since the test is not uniquely identified. By ensuring that a wide array of tests is defined in the LIS and EHR and all connected systems are updated as changes are made, these issues may be minimized.



<b>Management key points</b>	<b>Technical key points</b>
1. Need to have a system to manually notify interfaced clients of changes to your test catalog.	1. While no automated system for synchronizing test catalogs across interfaced systems currently exists, but HL7 is currently developing a standard to support automated synchronization.
2. It is important to have a good working relationship with the team maintaining each EHR.	2. Need to have a tracking system to ensure that changes have been propagated to all relevant systems.
3. In general, it is desirable to define as many tests as possible.	

### **MISTAKE #3: Not uniquely identifying test names using LOINC**

As we previously mentioned, LOINC is a system for coding medical observations and events developed by the Regenstrief Institute<sup>4</sup>; it is now a mandatory component of the Health Information Technology Framework and the “Meaningful Use” requirements for some coding of laboratory orders and results by clinical laboratories. Because of these federal efforts, support for LOINC codes will become ubiquitous in LIS and EHR systems, and laboratories will be expected to provide results that include LOINC codes so eligible providers (and hospitals) can qualify for incentive payments.

Because the use of LOINC is being driven by federal initiatives, the LIS user base will expect laboratory software vendors to provide the capability to support the use of LOINC as part of the basic/standard maintenance fee (without an) extra charge).

LOINC is a complex and rich system, which requires some background and education to properly use. When first implementing LOINC, laboratories must choose the proper code for each test in its catalog from the tens of thousands available. This requires someone with a strong laboratory background, since not all instrument/reagent vendors currently supply suggested LOINC codes for their assays. We recommend that laboratories identify at least one key staff member to become the “LOINCologist,” and that this person(s) participates in training programs, such as those offered by the Regenstrief Institute. Each laboratory should then form a team consisting of a pathologist or laboratory director, LIS manager and staff, and appropriate hospital information system staff to oversee the development and deployment of LOINC in the LIS and interfaced systems.

The LOINC website contains both the terminology and coding database itself as well as a program (“RELMA”) to assist the user in selecting the proper LOINC terms and codes for the LIS. Very helpful recent additions to the website include: “Top 300 Orders,” “Top 2000 Laboratory Observations,” and a mapper’s guide. Additionally, there is instructional material on the LOINC site to support all levels of LOINC proficiency, from beginner to expert. Laboratory leadership should anticipate a learning curve with these systems of at least a few weeks, depending on the expertise of assigned staff. This is not a trivial project, and significant resources and institutional support may be required if there is a short timeline to implement LOINC in your systems.

#### **Using LOINC in an HL7 message**

The drive to make various Medical Information Systems capable of seamlessly communicating with one another necessitates the adoption of standards that will support this goal by all participants. The HL7 (Health Level 7) standard has been developed and widely adopted for this purpose. HL7 is a messaging standard, containing many important fields, with two fields of particular interest with regard to transmission of lab results. These are OBX-3 (Observation Name) and OBX-5 (Observation Result). The ONC Lab Results Implementation Guide, required for EHR certification and stage 2 of Meaningful Use, mandates the use of HL7 as well as LOINC.

Will laboratories be required to LOINC encode 100% of their test catalogues? In the initial stages, many implementations may choose to code only the most frequent tests—or those tests needed for a particular purpose (eg, sending reportable disease information to public health departments for EHR certification). At this point, it is uncertain what extent of LOINC coding will be required to constitute compliance in the final phase of Meaningful Use. Certainly all common, locally performed tests should be coded, and the maximal benefit will be obtained when as many test orders and results as possible are transmitted with LOINC codes.

Many tests in the laboratory's catalog are performed by outside reference laboratories. Laboratory professionals should insist that their reference laboratories provide LOINC codes for all tests that they refer to the reference laboratory. Ideally, LOINC codes could be sent along with test results so that they can simply be passed along to receiving EHR systems, just as reference ranges currently are; however, this may not be technically feasible at the current time. Some laboratory instrument vendors provide suggested LOINC codes, a trend that will hopefully continue. Considering that many of the tests in a typical laboratory catalog are reference laboratory tests, the number of truly "local" tests requiring coding can be brought down to a very manageable number. The CAP's Professional Services group provides advisory, consulting, and solutions to laboratories, pathologists, and the health care provider community. In addition, consultants are available who can assist in the LOINC code assignment process.

Management key points	Technical key points
1. Begin your LOINCing process by obtaining LOINC codes from reference laboratories (and any outside laboratory performing testing for you) for all assays they perform for you.	1. Determine capability of local systems (LIS & EHR) to include LOINC codes in their interfaces.
2. Contact all manufacturers of instruments used in your laboratory. They might be able to provide LOINC codes for the methodologies on each machine. You may need to go deeper into the organization than the sales force.	2. Recognize that you may need to upgrade your LIS or the receiving EHR to a version that has LOINC support.
3. Assign one or two individuals with laboratory experience as "LOINCologists" to be the expert(s) in assigning codes	

#### **MISTAKE #4: Assuming that it will be easy to establish a secure electronic connection**

Many laboratory professionals only think about the electronic messaging aspects when discussing interconnectivity, but before two systems can exchange protected health information (PHI), they need to have a secure electronic connection. A common way to accomplish this is to create a virtual private network (VPN). A VPN is a persistent encrypted connection between a network and an outside device, usually via the Internet. However, proper security requires not only the use of standard secure communication protocols but also the management of sending and receiving systems to mitigate the risks of compromise by outside parties. This includes issues such as using proper antivirus, firewall, and other protective software; regular patching of the operating system software; and upgrading to current versions of software when vulnerabilities are identified in older versions, etc.

Though hard to believe, it can take months to establish a single VPN connection in some large health care organizations. This is especially true if you are connecting directly to a system in a small medical office, since it may have limited IT staff, rely upon outside support, and not have rigorous server management, etc. Large health care organizations often have a long list of security requirements that need to be satisfied before they will establish a connection. In addition, as the number of connections requested increases throughout the organization, the laboratory's request may be placed at the end of a very long queue. One way to reduce the laboratory's dependence upon overtaxed internal groups to establish connections is to consider using middleware systems. It may be possible to establish one VPN tunnel to a middleware vendor, and then have the vendor build any needed additional tunnels to the individual laboratory clients. In that way the laboratory avoids the potentially onerous task of having to deal with internal information security departments for each individual client.

Other options include "file drop" systems where one system uses secure FTP (file transfer protocol) or other tools to place files containing electronic messages into a secure folder on a client's server. While this still requires secure electronic communication since the contents include PHI, there is no requirement for ongoing, real-time two-way communications; and if the communication is only one way (eg, from laboratory to office), then the security considerations may be less formidable.

Another option to explore is The Direct Project, which creates a "simple, secure, scalable standards-based way for participants to send authenticated, encrypted health information directly to known, trusted recipients over the Internet."<sup>5</sup> This can provide a secure substitute for email or fax communication, and it may be useful in certain situations where a full interface is impractical or cost prohibitive.

For bidirectional communications, such as test ordering (office to laboratory) and the subsequent test results (laboratory to office), the ideal solution is a VPN or other real-time networking approach. This allows for validation and verification of messages in real time (eg, the laboratory systems can send back

error messages if the test ordered is unknown). There may be other workable approaches for communications regarding test results; but if a laboratory is interested in building highly functional interfaces with client EHR systems, then a dedicated connection is a likely necessity.

While creating electronic connections is a fairly technical exercise, a role exists for the laboratory director/pathologist to ensure that sufficient attention is being given to creating the connection in a reasonable time frame. If problems arise, it is helpful for someone with sufficient influence to work to ensure that the proper people or resources are employed. For instance, just taking the time to call the head of the hospital/health network group to explain the effect that a delay in establishing a connection may have on clients and patients may help to move a stalled project.

Management key points	Technical key points
1. Bidirectional real time interfaces offer the most functionality.	1. Secure connections require a complete security infrastructure and processes, not just software.
2. Secure connections are mandatory but may take time to install.	2. Be aware that smaller office practices may have limited IT resources/expertise.
3. The pathologist may have a role in ensuring that roadblocks in the process are overcome.	

#### CAP Accreditation Requirements for Initial Validation of Interface Results - GEN.48500<sup>6</sup>

At least two examples of reports from each of the following disciplines (as applicable):

- Surgical pathology
- Cytopathology (preferably Gyn and Nongyn)
- Clinical lab textual reports
- Quantitative results
- Qualitative or categorical results
- Microbiology reports
- Blood bank reports

You may use a subset of tests, but you must test **ALL** interfaced systems.

## MISTAKE #5: Not having a thorough testing plan

With the move to electronic health records throughout the health care system, laboratories are being asked to create and maintain many more laboratory order and result interfaces. A critical part of this process is that laboratory directors must ensure that critical functionality is present and stable. This includes assurance that:

- Information flowing from the LIS to the EHR is accurate and complete.
- Formatting is logical and human readable on the receiving end, maintaining the essential elements of the report as it was entered into the LIS.
- Any coded information needed to correctly identify results, such as LOINC codes, are appropriately sent and received.
- Report versioning, reference ranges, comments, and abnormality flags are handled properly.
- The full pathway for information flow has been tested from end to end (eg, reference laboratory to LIS to office practice EHR).

Validations with reference laboratories and with end users (be that a hospital EHR, an outside clinic, or a physician office) are needed and, indeed, required by the CAP Laboratory Accreditation Program. The Laboratory Accreditation Program checklists have been updated to ensure that interface validations are performed with sufficient rigor and frequency.<sup>6</sup> Note that the specific requirements are the minimum and that test plans should be customized to the specific situation. Automated testing software is available that can allow for partially automating the testing process, which can be a real time saver, especially if you need to revalidate interfaces after system upgrades. Test cases should be sent both up- and downstream, and the laboratory director or a designee (either/both of whom should also be a participant in institutional health IT conversations) should review the results periodically. Just as laboratory directors are responsible for minimizing pre-analytical, analytical, and post-analytical errors to the best of our ability, so too are they responsible for the information received by their clients. This means periodic validation is needed for **each** system to which the laboratory transmits information (hospital EHRs, clinic office EHRs, etc) to ensure that the data on which our clinician clients base their decisions is of the quality they have learned to expect from their pathologist.

Another related consideration is interface error queues. Most EHRs have the capability to log and track instances where a result or order message is not processed successfully. Some serious message errors

### Automated Software Testing

In recent years, a number of vendors have introduced packages to automate the testing/validation process. An external set of testing programs simulates keystrokes and other data entry, and then electronically reads screen output to verify that the desired outcome is achieved. These tools have a number of important advantages: 1) Scenarios can be checked multiple times, 2) outputs may be rigorously compared against intended outcomes, 3) all interactions are audit trailed, and 4) a complete set of testing can be run whenever an adjustment is made to the system.

are detectable by the LIS, such as a message not being acknowledged due to a connectivity issue. However, other errors will only show up on the EHR error log, and some medical practices may not be monitoring this error log routinely. A classic case of a message that will not process correctly is when a new order/result code has been defined in the laboratory system but not in the EHR. In this case, the laboratory must depend upon the EHR administrator to notify it of the error so that it can be investigated and corrected. Ideally, an electronic version of the EHR error log would be available to laboratory information system administrators, but this is not currently a common occurrence.

<b>Management key points</b>	<b>Technical key points</b>
1. Create a process for initial and periodic interface validation.	1. Test the entire chain of interfaces.
2. Perform targeted validation when significant changes are made	2. Ensure that interface error logs work as expected and a procedure exists for monitoring them.
3. Obtain a written agreement with receiving system acknowledging that it has responsibility to inform the laboratory of significant changes (eg, upgrades) to its EHR so that you can revalidate	3. Use a test environment if possible.
	4. Use test patients when working in the live environment.
	5. Consider automated testing software to help make the testing process faster, more accurate, more complete, reproducible, and better documented.

## **MISTAKE #6: Failing to recognize that validation of the EHR result display is an important responsibility**

What does digital computing mean without a user interface? Our systems are capable of data input into complex architectures, data manipulation, and data output in any number of ways. But the human still requires a visual interface with the system.

Validation of result display is now an essential part of the role of the pathologist in medicine. Interface validation encompasses the transfer of the data and should also include assessment of the user interface (ie, the human experience of accessing the data via the result display screens). Monitoring result displays is an important quality focus both in the laboratory information system as well as in the EHR. Frequently, a user interface is not intuitive—have you ever wished for a paper chart, where “at least I knew where to look”? While that question likely demonstrates some selective and collective amnesia (paper charts were often incomplete), it does capture the main issue: Data should be presented in a logical, legible,<sup>7</sup> and intuitive manner that allows a streamlined and continuous end user workflow.

The process of implementing a new interface between a laboratory information system and an EHR encompasses a variety of steps. One step that is easily overlooked is to have a pathologist review the user display of the laboratory results in the EHR. While the laboratory and pathologist may not have specific control over the basic functioning of the result display, it is important to be familiar with the functionality and to validate that the laboratory data is complete and usable. The laboratory director is responsible for the contents of laboratory reports, be it paper or electronic; therefore, ensuring that the data is effectively presented is also within his/her domain. Quality assurance procedures should be designed and implemented such that laboratory client user interfaces—hospitals, clinics, physician offices, etc—are periodically monitored. Procedures should consider top-level issues generic enough to define system independent items as well as to tailor them to system or specialty-specific variables.

Top-level issues may be as basic as: Is the “Laboratory” tab easily found? Are test names represented in a logical manner? Are results grouped into order-set names? (eg, if the clinician orders a Comprehensive Metabolic Panel [CMP], are the results presented as CMP?) Is the IFE result near the SPEP result? If a bronchoscopy resulted in an FNA (cytology specimen) and a biopsy (surgical specimen), can it be determined from the interface that the two are “linked”?

### **CAP Accreditation Requirements<sup>6</sup>**

#### **GEN.41067 – Report Review**

An individual meeting CAP laboratory director qualifications reviews and approves the content and format of paper and electronic patient reports at least every two years.

#### **GEN.41096 – Report Elements**

There are 10 mandatory report elements that paper and electronic reports must contain. Data elements do not all have to be on a single screen, but they must be readily available.



Honing down, care should be taken to monitor client-specific issues: a hospital ICU interface should allow frequently updated graphical views of certain measures (lactate, glucose, arterial pH, etc) while such information is rarely needed in the family practice office setting, where longer-term trends in glucose, HbA1c, body weight, etc, may be more valuable. Both settings would benefit from having flagged or out-of-range results highlighted in some manner.

Once the EHR user-interface-monitoring plan is created and implemented, revisions will be needed when changes are made in the laboratory. New tests, new analytes, addition of calculations, or text must be monitored in all settings before “go-live” to ensure quality and reduce risk of end-user misunderstanding and consequent influence on patient care. As with the system interface itself, the CAP Laboratory Accreditation Program includes requirements to ensure that periodic assessment of electronic reports is part of general laboratory operating procedures.

Client-side information management is a relatively new arrival to the pathologist's list of responsibilities. Most user-interfaces that clinicians use are contained in EHRs, which are typically outside of the purview of the pathologist. Still, the laboratory director is responsible to ensure that laboratory results are visible to the end user in ways that accurately reflect the information. The laboratory and laboratory director need to take ownership of this issue and forge ties with the people/departments who maintain and update the EHRs in order to be able to work together to improve the quality of information available to the clinician.

Management key points	Technical key points
1. Create an interface validation process that includes evaluation of the result display.	1. Don't assume that there is a single way to view results in an EHR—there are often several views.
2. Validate periodically, but also when any significant system changes are made.	2. Upgrades to an EHR may include a new way to view results.
3. Communicate actively with clients and people/groups that provide technical support for the EHR systems.	

## **MISTAKE #7: Not recognizing challenges and pitfalls associated with patient identifiers**

One of the challenges facing laboratories is that of patient identifiers. In particular, this is an issue for hospital-based laboratories performing work on patients who are shared between multiple private practices, each with separate EHRs, and the hospital health information system (HIS). In order to provide the best patient care, it is often desirable that the HIS has a record of all testing performed on a given patient. The requests for the testing may originate from a variety of different EHR systems, each of which uses a different local medical record number.

One way to avoid complexities is to treat each specimen as a unique encounter, not tied to any past encounters, and allow the originating EHR to associate results over time on the same patient. However, this is problematic for the patients in multiple ways, including the laboratory's inability to use prior laboratory results or other existing clinical information for quality assurance purposes, such as delta checks or correlation of laboratory results with clinical status.

A better way to avoid this issue is to have one consistent identifier that is used by all of the entities who interact with a patient. This may be possible for consolidated health care systems, but in many situations there are different patient medical record numbers assigned by each entity within the system. One way to mitigate this issue is by use of an Enterprise Master Patient Index (EMPI), which is essentially a large table that lists the local medical record numbers of a given patient within each electronic system in the health care enterprise. However, despite their promise, the reality is that even EMPI systems may have issues, such as duplicated patients. One additional alternative is the use of the Voluntary Universal Health Identifier (VUHIT). (See Additional Resources section.)

Laboratories will need to ensure that they have the ability to either manually or electronically match patient information from a requisition (paper or electronic) to a patient who has been previously registered in the LIS or HIS. LIS systems will often provide the ability to store two or more medical record numbers for a patient, one used in the LIS/HIS and one or more from a client EHR (a so-called foreign system patient identifier). Typically, however, multiple name fields are not available (eg, there is not usually a foreign-system patient name field), since the general assumption that the name of a specific patient will be the same in every electronic system is not always true.

### **Biometrics**

While we recognize that only a few health systems use biometric patient identification, we believe that this could become the standard of practice.

A variety of biometric techniques make use of unique characteristics of each person's body. These include:

- Palm vein
- Fingerprint
- Iris pattern
- Finger vein
- Hand configuration
- Face recognition
- Voice print

Text-based algorithms may be used to automate the matching of patient information, but there are potential pitfalls to this if the algorithm is not carefully selected and evaluated for the local circumstances. For instance, if a client EHR uses a matching algorithm that includes the patient name fields, there are potential issues related to how patients are registered in each system. Are suffixes included in the last name field or ignored? What about middle initials? Are proper names or nicknames used? All of these seemingly trivial details will matter if an exact match is required in the name field. No single patient identification field will be sufficient, so typically multiple fields are used, including name, date of birth, local medical record number, etc.

Mismatches due to discrepancies in these fields are not uncommon, especially if multiple patient instances have been created by accident. Merging these files is typically a tedious job and all of the relevant electronic systems, such as the LIS may need to be updated as well. For example, if an office accidentally creates a new patient file for an established patient and submits testing under the new office medical record number, then realizes the error the next day and wants the laboratory results to file correctly, the laboratory may need to manually create a new transaction, re-enter the results and retransmit them. Obviously, standardization of the processes around data entry and registration of new patients is important. The more a group of health care entities can use the same medical record number or implement a comprehensive EMPI, the easier it is to create a longitudinal medical record that provides value to the patient and clinicians.

The ideal future state would be to include biometric identification of patients using unique physical characteristics (see side bar). This technology is beginning to be adopted within institutions, but it is not at the point where it is in common use among different health care entities (ie, facilities that are not part of the same health care delivery network). However, in the interests of patient safety, it is imperative to move in this direction, as these physical methods of identification are more robust than the patient identifiers currently in use.

Management key points	Technical key points
1. Need to plan for scenarios where the laboratory and the EHR use different patient identifiers.	1. Enterprise Master Patient Indexes allow a number of different identification numbers for a single patient to be cross-referenced.
2. If you are using an algorithm to match patients based on a variety of information fields, try to standardize process for entering that information (eg, name formats).	2. Early adopters are incorporating biometrics, which are potentially more robust mechanisms to identify patients.

## **MISTAKE #8: Not considering all results delivery situations**

The stereotypical workflow of a single clinician submitting a requisition for laboratory testing on an outpatient and getting the results sent back to his/her office EHR is a straightforward situation that generally does not pose too many difficulties. However, there are many variations on this standard workflow—especially with outpatients—that are more complicated and that current systems may not be designed to accommodate. These include:

### **1. “Copy-to” Results:**

When a laboratory order includes a “copy-to” request, ideally there would be a way for an LIS to electronically send the results to all providers who should be notified. However, providers may not be in the same practice and/or may not use the same EHR system. Even if the providers are in the same practice and use the same EHR, the EHR may not be able to notify more than one provider that new results are available for viewing. On the laboratory side, the LIS may only be able to send one electronic message for a given report that must be directed to the EHR associated with the ordering clinician, since he/she is the one responsible for taking action on the results.

Another challenge related to copy-to results is that there is often no way to ensure that all physicians who would like to receive results for a particular specimen are identified on the order/requisition. The usual scenario, especially in anatomic pathology, is that the person who obtains the specimen is considered the ordering physician, but in many cases the patient may have a different primary care physician (PCP) or specialist who also needs those results. While the laboratory typically cannot solve this issue, it is often involved. At a minimum, the laboratory can raise awareness or make changes to the paper or electronic requisition to increase the likelihood of obtaining the information at the time of the original order.

In the laboratory, there may be a variety of ways to address these issues, including customizing the LIS, using an interface engine that creates rules for sending messages to multiple EHRs, or using a middleware solution. Longer-term solutions include lobbying LIS and EHR vendors to implement features to allow for these more complicated result flows to be handled gracefully by the applications.

### **2. Aggregating laboratory results obtained from different locations into a clinician's EHR:**

A second related issue is that patients are seen in multiple settings (eg, clinic, ED, nursing home), and providers request receipt of all laboratory results in their EHR regardless of where the order/sample originated. It is usually not a problem in an integrated delivery system where all providers at all sites use the same EHR, but in many situations there are separate systems in the office, the hospital, specialized clinic, etc.

The same sorts of solutions that are mentioned above may be helpful in this circumstance. In addition, a central data repository, which takes information from multiple laboratories throughout a health system or geographic area and can aggregate the data by patient, would be a way of addressing this need. However, if a clinician is using an EHR in a practice, he/she will likely desire that all results be sent there, so that EHR alerting functions and other workflow tools, such as tracking, overdue or abnormal results, generation of patient letters, etc, can be used. Also some providers may be resistant to look for results in more than one system because of the extra time involved.

### 3. Results that are filed after an inpatient is discharged:

A third related issue occurs when results are finalized after an inpatient is discharged. This information needs to be brought to the attention of a responsible clinician, either the ordering clinician or the attending or PCP or appropriate health care professional. However, a common circumstance is that the HIS handles inpatient results and outpatient results are tracked in a different EHR. If the new results are simply reported electronically in the HIS, there is often no function that alerts the ordering physician that new results are available unless the clinician looks up a particular patient. It is unrealistic to expect that a clinician will remember that tests are still pending on a discharged patient and will check the HIS each day until the results are ready. The typical workaround in this situation is to print paper reports and deliver them to a responsible physician. One possible issue with this arrangement is that if these paper reports are sent to an office that is used to receiving *all* reports electronically, it may ignore the paper without reviewing the results. In order to avoid this fate, consider adding a visual cue that the report is unusual, such as colored stickers or a colored cover sheet explaining why the results were sent. The adoption of integrated EHR systems, which include both inpatient and outpatient information, will probably rectify this issue, as long as a robust electronic notification system is in place. For situations where the inpatient and outpatient systems will remain separate, laboratories should work with the relevant vendors to incorporate ways of sending reports or notifications to clinicians electronically in such a circumstance.

Management key points	Technical key points
1. Clinicians often desire that all relevant laboratory results on their patients be sent to their primary EHR, but current systems may have limitations in this regard.	1. Local circumstances will dictate how and whether such requests can be met.
2. Consider how to handle laboratory results on discharged patients.	2. If a systemwide EHR is not in use, then interfacing with multiple EHR systems via interface engines or middleware may be necessary.
3. Work with ordering clinicians to ensure that all relevant referring physicians are included in the test order.	

**MISTAKE #9: Not anticipating that results may be passed through multiple EHRs**

As the path of the transmitted laboratory result becomes more complex and less predictable, the chance of error grows. A result may pass from the laboratory equipment over the interface engine into one LIS, which may make the result available to another LIS via another interface. From there it may pass through another interface engine into an EHR, which in turn can pass it to an HIE (and other EHRs) or a Personal Health Record (PHR). At each of these steps there may be limitations or incompatibilities, such as differences in the maximum number of characters per line or maximum number of lines permitted in a textual result. Sometimes systems will handle this gracefully, adding a notice that the result was too long and is unable to be displayed completely. Unfortunately, instances where the results are simply truncated, without any indication to the viewer, do occur. At the heart of the issue is the fact that field quantity, field length, and device screen real estate define the capabilities of the receiving/displaying system. These capabilities are not negotiated at the time of result transmission, and no standard exists for displaying systems.

This leads to the question of how the pathologist and laboratory should handle circumstances like these. For directly interfaced systems, it is clear that the laboratory director has the responsibility for ensuring that the results are received and displayed correctly. However, it is not clear how far downstream this responsibility extends. Clearly it would be ideal to validate every result type in every possible downstream system, but even today that is often impractical or even impossible (since the laboratory may not even know about every possible downstream system). The Laboratory Accreditation Program of the CAP has taken the position that the laboratory must ensure correct transmission and display of the test results in the first downstream or interfaced system where the clinician routinely reviews results (LAP CAP GEN.48500). Moreover, the best practice is to try to identify all downstream systems with result display capability and perform an appropriate validation with each of them.

What a laboratory will be able to accomplish will depend on the particular local circumstances. It makes sense to establish a working relationship with the “owners” of each EHR that will be receiving data and to attempt to validate result displays in as many systems as feasible, since this is the only protection against undesirable outcomes. For hospital laboratories, a pathologist should be involved in the committee that oversees the clinical information systems to ensure that laboratory issues are adequately considered whenever changes are contemplated.

<b>Management key points</b>	<b>Technical key points</b>
1. Best practice is to validate result display in all systems known to receive results.	1. Limitations in interfaces and displays vary from system to system.
2. Good working relationships with those responsible for each system are invaluable.	2. There may not be any indication to a user that a result is incomplete.
3. For hospital laboratories, a pathologist should be involved in the clinical IT committee.	
4. Obtain a written agreement that if an EHR passes laboratory data on to another system, it will notify the laboratory so that a proper validation can be done.	

## **MISTAKE #10: Assuming that EHRs can properly depict complex reports**

Laboratory reporting serves a number of purposes. The first and most important purpose is to present a document that the clinician can read, understand, and rely upon to take appropriate action. However, the move to EHRs has led to a second important functional requirement: the ability to store data elements, such as test results, individually, so that they may be presented to the user in other ways (eg, graphically, in tables, etc) and used for clinical decision support. This move to send data in discrete elements has extended to textual reports, such as anatomic pathology. The steps taken towards introducing discrete data have created an unintended casualty: the integrity of the signed, carefully laid-out report has been partially traded for the ability to make the text of a report available to systems that cannot handle complex (or sometimes even simple) text formatting. Relying on the HIS/EHR to properly display long textual reports has resulted in unannounced truncation of reports at an arbitrary line length leading to loss of key words from the report (eg, "...No evidence of malignancy" being displayed as "...evidence of malignancy") and scrambling of results displayed in a table.

Fortunately, there is a way to address this issue. The most practical approach today is for the LIS to package a complex report as a portable document format (PDF) document, and for the EHR to receive, store, and display this PDF exactly as it was generated.<sup>8</sup> For over a decade, it has been a standard use of HL7 interfaces (as implemented in Australia) to include PDF reports within encoded HL7 segments. Alternatively, interface designers may prefer to send a Web link across the interface and rely on the receiving system to retrieve that PDF file from the sending system.

Here we have emphasized the use of a widely accepted computer industry standard—the PDF. However, in the future we may be able to evolve to use of health care-specific standards that fully retain formatting information along with discrete data. Such an example is the HL7 CDA (Clinical Document Architecture). It would be quite acceptable for sending and receiving systems to represent and transmit report documents in CDA format with an associated style sheet. However, since it is specific to health care and far fewer systems today can produce, receive, and display CDA documents consistently, it is not our primary recommendation.

### **PDF lab reports**

With the current generation of systems a report with an accurate layout can be sent as a PDF document; eventually reports may be represented as XML/CSS (or using ePUB), which could enable multiple accurate layouts. While a single PDF file does not reflow text or adjust its layout based on the resolution of the display (as can ePUB), it ensures that the contained text does not become obscured and preserves the intended layout. PDF/A, now in version 3 (PDF/A-3) is an ISO standard and allows embedding of discrete XML data. Alternatively a PDF can be embedded in a CDA document containing the discrete data.



Unfortunately, not all LIS or EHR systems can create or accept/display PDF files, so the laboratory director is left in the unenviable position of having to make tradeoffs between what is currently feasible and what would be ideal. At a minimum, the laboratory should be strongly lobbying for including PDF or CDA capabilities in existing systems or upgrading to systems that have such capabilities.

A second use case for laboratory reporting is clinical decision support, using detailed data embedded in the laboratory findings to perform computations. Examples include antibiogram calculations in microbiology and trending for common chemistry, hematology, and immunology analytes. It is not feasible for the EHR to extract detailed atomic data from a PDF of an entire multipage pathology report. Therefore, in *addition* to the PDF human-readable report recommended above, the laboratory should report all discrete data elements via a standard HL7 message, where each result is transmitted in a distinct HL7-compliant record. Standardized, structured reporting is of greatest value where there is both a well-formatted report (for the clinician's comprehension of all distinct findings) and an HL7 discrete data transmission (to make all of the discrete data elements fully computable).

In the future, all result-reporting interfaces between the LIS and external systems should incorporate *both* elements. The PDF is essential to ensure that the clinician can see and follow the full report; the fielded HL7 provides discrete data for analyses and trending.

Management key points	Technical key points
1. Ensure that your LIS can create PDF versions of reports—especially for complex reports.	1. PDFs may be embedded in HL7 OBX segments.
2. Work with interfaced EHRs to receive and display these LIS-formatted PDFs.	2. Alternatively, the LIS can send a Web link address to the EHR, and the EHR can display that Web page.
3. If you are hospital based, work with other departments that generate complex reports to harmonize the approach to send and display PDF files.	3. Discrete data elements should be transmitted simultaneously via HL7, but the EHR should not attempt to reconstruct a complex formatted report from discrete elements.

**SUMMARY**

In this white paper we have reviewed ten issues related to creating and maintaining laboratory interfaces and suggested some practical solutions. Being forewarned about these issues and applying the techniques mentioned should allow a laboratory to avoid at least some of the pitfalls addressed in this document. Clearly, the later stages of meaningful use with their more stringent requirements will drive an increase in the number and complexity of laboratory interfaces. In addition, the creation of accountable care organizations (ACOs) will drive mergers, realignments, and any manner of changes to which the laboratory must be ready and willing to respond. We will have succeeded in our goal if you, the reader, are able to set reasonable and relevant expectations for your interfacing projects and avoid the worst of these pitfalls on your path to success.

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**APPENDIX 1: GLOSSARY**

A Glossary of common acronyms and terms related to health IT

<b>Acronym</b>	<b>Description</b>	<b>Website/References</b>
<b>ACA</b>	<b>Affordable Care Act</b> The Patient Protection and Affordable Care Act (PPACA), also known as the federal health care law, is a 2010 US federal statute to decrease the number of uninsured Americans and reduce the overall cost of health care.	<a href="http://www.healthcare.gov/law/features/index.html">http://www.healthcare.gov/law/features/index.html</a>
<b>ACO</b>	<b>Accountable Care Organization</b> Coordinated care systems in which providers are incentivized on the basis of outcomes rather than the number of services.	<a href="http://www.gpo.gov/fdsys/pkg/FR-2011-11-02/pdf/2011-27461.pdf">http://www.gpo.gov/fdsys/pkg/FR-2011-11-02/pdf/2011-27461.pdf</a>
<b>CDA</b>	<b>Clinical Document Architecture</b> An HL7 document markup standard that specifies the structure and semantics of "clinical documents" for the purpose of exchange between healthcare providers and patients. It can contain any type of clinical content – eg, Discharge Summary, Imaging Report, Admission & Physical, Pathology Report and more. The most popular use is for inter-enterprise information exchange, such as is envisioned for a US Health Information Exchange (HIE).	<a href="http://www.hl7.org/implement/standards/product_brief.cfm?product_id=7">http://www.hl7.org/implement/standards/product_brief.cfm?product_id=7</a>
<b>DIHIT</b>	<b>Diagnostic Intelligence and Health Information Technology</b> A CAP committee whose mission is to establish the role of pathologists on the health care team as recognized stewards of clinical and diagnostic data integration and utilization.	<a href="http://www.cap.org">www.cap.org</a>
<b>Direct</b>	<b>Direct Project</b> The Direct Project specifies a simple, secure, scalable, and standards-based way for participants to send authenticated, encrypted health information directly to known, trusted recipients over the Internet.	<a href="http://wiki.directproject.org/">http://wiki.directproject.org/</a>
<b>eDOS</b>	<b>Electronic Directory of Service</b> An initiative of ONC Standards and Interoperability (S&I) Framework Laboratory Initiatives Pilots that aims to provide an	S&I: <a href="http://wiki.siframework.org/Laboratory+Initiatives+Pilots">http://wiki.siframework.org/Laboratory+Initiatives+Pilots</a> eDOS:

	electronic interchange of a laboratory's directory of services in a structured format based on HL7 2.5.1.	<a href="http://wiki.siframework.org/LOI+-+eDOS">http://wiki.siframework.org/LOI+-+eDOS</a>
<b>EHR</b>	<p><b>Electronic Health Record</b></p> <p>The aggregate electronic record of health-related information on an individual that is created, gathered and shared cumulatively across multiple facilities or healthcare organizations and is managed and consulted by licensed clinicians and staff involved in the individual's health and care.</p> <p>Sometimes used interchangeably with <b>EMR</b> (Electronic Medical Record).</p>	<p>ONC/NAHIT: <a href="http://whatis.techtarget.com/definition/electronic-health-record--ehr-.html">http://whatis.techtarget.com/definition/electronic-health-record--ehr-.html</a></p> <p>HIMSS: <a href="http://www.himssanalytics.org/docs/WP_EMR_EHR.pdf">http://www.himssanalytics.org/docs/WP_EMR_EHR.pdf</a></p> <p>ONC site: <a href="http://www.healthit.gov/providers-professionals/learn-ehr-basics">http://www.healthit.gov/providers-professionals/learn-ehr-basics</a></p> <p>HITECH Answers website: <a href="http://www.hitechanswers.net/key-definitions/">http://www.hitechanswers.net/key-definitions/</a></p> <p>CMS: <a href="https://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/index.html?redirect=/EHRIncentivePrograms/">https://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/index.html?redirect=/EHRIncentivePrograms/</a></p>
<b>EMR</b>	<p><b>Electronic Medical Record</b></p> <p>A digital version of the traditional paper-based medical record for an individual. The EMR represents a medical record within a single facility, such as a doctor's office, clinic, or hospital, and it is the source of data for the EHR.</p> <p>Sometimes used interchangeably with <b>EHR</b> (Electronic Health Record).</p>	<p>HIMSS: <a href="http://www.himssanalytics.org/docs/WP_EMR_EHR.pdf">http://www.himssanalytics.org/docs/WP_EMR_EHR.pdf</a></p> <p>ONC: <a href="http://whatis.techtarget.com/definition/electronic-medical-record--emr-.html">http://whatis.techtarget.com/definition/electronic-medical-record--emr-.html</a></p> <p>HITECH Answers website: <a href="http://www.hitechanswers.net/key-definitions/">http://www.hitechanswers.net/key-definitions/</a></p>
<b>ePUB</b>	<p><b>Electronic Publication</b></p> <p>A free and open ebook standard by the International Digital Publishing Forum.</p>	<a href="http://idpf.org/epub">http://idpf.org/epub</a>
<b>FTP</b>	<p><b>File transfer protocol</b></p> <p>A standard network protocol used to transfer files from one host to another host over a Transmission Controlled Protocol (TCP)-based network, such as the Internet. FTPs promote sharing of files (computer programs and/or data) and transfer data reliably and efficiently.</p>	<p><a href="http://en.wikipedia.org/wiki/File_Transfer_Protocol">http://en.wikipedia.org/wiki/File_Transfer_Protocol</a> and <a href="http://tools.ietf.org/html/rfc959">http://tools.ietf.org/html/rfc959</a></p>
<b>HIE</b>	<p><b>Health Information Exchange</b></p> <p>Created when health care information is electronically collected across organizations within a region, community or health system. Grants to support some of these exchanges were legislated into the</p>	<a href="http://healthit.hhs.gov/portal/server.pt?open=512&amp;objID=1488&amp;parentname=CommunityPage&amp;parentid=58&amp;mode=2&amp;in_hi_us_erid=11113&amp;cached=true">http://healthit.hhs.gov/portal/server.pt?open=512&amp;objID=1488&amp;parentname=CommunityPage&amp;parentid=58&amp;mode=2&amp;in_hi_us_erid=11113&amp;cached=true</a>

	HITECH part of ARRA. Sometimes called Regional Health Information Organizations (RHIOs).	
<b>HITECH</b>	<p><b>Health Information Technology for Economic and Clinical Health Act</b></p> <p>Enacted as part of the American Recovery and Reinvestment Act of 2009, signed into law on February 17, 2009, and promotes the adoption and meaningful use of health information technology.</p>	<a href="http://www.hhs.gov/ocr/privacy/hipaa/administrative/enforcementrule/hitechenforcementifr.html">http://www.hhs.gov/ocr/privacy/hipaa/administrative/enforcementrule/hitechenforcementifr.html</a>
<b>HL7</b>	<p><b>Health Level Seven</b></p> <p>An international standards organization that develops and publishes voluntary consensus technical standards for interoperability of health information technology.</p>	<a href="http://www.hl7.org/">http://www.hl7.org/</a>
<b>Interface engines</b>	An HL7 interface engine is an interface or integration engine built specifically for the healthcare industry. It connects legacy systems by using a standard messaging protocol.	<a href="http://www.hl7.com/interface_engine/">http://www.hl7.com/interface_engine/</a>
<b>LOINC</b>	<p><b>Logical Observation Identifier Names and Codes</b></p> <p>A database that provides a universal code system for reporting laboratory and other clinical observations that is available in multiple languages. In addition to laboratory tests, LOINC also includes clinical measures, imaging tests, and document architecture.</p>	<a href="http://www.regenstrief.org/loinc/">http://www.regenstrief.org/loinc/</a>
<b>Middleware</b>	Software that mediates between an application program and a network. It manages the interaction between disparate applications across the heterogeneous computing platforms.	<a href="http://foldoc.org/middleware">http://foldoc.org/middleware</a>
<b>MU</b>	<p><b>Meaningful Use</b></p> <p>The American Recovery and Reinvestment Act of 2009 specifies three main components of Meaningful Use:</p> <ol style="list-style-type: none"> <li>1. The use of a certified EHR in a meaningful manner, such as e-prescribing.</li> <li>2. The use of certified EHR technology for electronic exchange of health information to improve quality of health care.</li> <li>3. The use of certified EHR technology to submit clinical quality and other measures.</li> </ol>	<a href="http://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/Meaningful_Use.html">http://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/Meaningful_Use.html</a>

	Simply put, "meaningful use" means providers need to show they're using certified EHR technology in ways that can be measured significantly in quality and in quantity.	
<b>ONC</b>	<b>Office of the National Coordinator for Health Information Technology</b> A position within the US Department of Health & Human Services (HHS) created by Executive Order in 2004 and written into legislation by the HITECH Act. Its purpose is to promote a national health Information Technology infrastructure and oversee its development.	<a href="http://healthit.hhs.gov/portal/server.pt?open=512&amp;objID=1200&amp;mode=2">http://healthit.hhs.gov/portal/server.pt?open=512&amp;objID=1200&amp;mode=2</a>
<b>PDF</b>	<b>Portable Document Format</b> A file format used to represent documents in a manner independent of application software, hardware, and operating systems.	<a href="http://en.wikipedia.org/wiki/Portable_Document_Format">http://en.wikipedia.org/wiki/Portable_Document_Format</a>
<b>PHR</b>	<b>Personal Health Record</b> A health-related documentation maintained by the individual.	<a href="http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1447551/">http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1447551/</a>
<b>RELMA</b>	<b>Regenstrief LOINC Mapping Assistant</b> A mapping program to assist the mapping of local test codes to LOINC codes and to facilitate browsing of the LOINC results.	<a href="http://www.regenstrief.org/loinc/">http://www.regenstrief.org/loinc/</a>
<b>VPN</b>	<b>Virtual Private Network</b> A private network that interconnects remote (and often geographically separate) networks through primarily public communication infrastructures such as the Internet. VPNs provide security through tunneling protocols and security procedures [1] such as encryption. For example, a VPN could be used to securely connect the branch offices of an organization to a head office network through the public Internet.	<a href="http://en.wikipedia.org/wiki/Virtual_private_network">http://en.wikipedia.org/wiki/Virtual_private_network</a>
<b>XML</b>	<b>Extensible Markup Language</b> A markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable	<a href="http://en.wikipedia.org/wiki/XML">http://en.wikipedia.org/wiki/XML</a>

## APPENDIX 2: ADDITIONAL RESOURCES

Below are some additional resources that can provide additional information:

The National Library of Medicine has grouped a variety of available resources together at the following sites: [http://www.nlm.nih.gov/hit\\_interoperability.html](http://www.nlm.nih.gov/hit_interoperability.html).

Laboratory Interoperability Cooperative:

<http://www.labinteroperabilitycoop.org/index.htm>

Integrating the Healthcare Enterprise:

<http://www.ihe.net/>

Meaningful Use resources:

[http://healthit.hhs.gov/portal/server.pt/community/healthit\\_hhs\\_gov\\_meaningful\\_use\\_resources/3006](http://healthit.hhs.gov/portal/server.pt/community/healthit_hhs_gov_meaningful_use_resources/3006)

Healthcare Information technology and management systems:

[www.himss.org](http://www.himss.org) (See also the Dictionary of Healthcare Information Technology Terms, HIMSS Press, 3rd edition, HIMSS, Chicago, 2013 (Raller)

HITECH Programs and Advisory Committees:

<http://healthit.hhs.gov/portal/server.pt?open=512&objID=1487&mode=2>

Unified Code for Units Measure (UCUM):

<http://unitsofmeasure.org/> and

<http://www.hl7.de/download/documents/ucum/ucumdata.html>

Voluntary Universal Health Identifier (VUHIT)

<http://gpii.info/>

CAP resources:

1. To contact members of the Diagnostic Intelligence and Health Information Technology committee, contact: [Informatics@cap.org](mailto:Informatics@cap.org).
2. CAP Consulting provides advisory, consulting and solutions to laboratories, pathologists, and the health care provider community. CAP's team has deep expertise in LOINC and provides services to help laboratory clients LOINC-encode their test compendiums. CAP also assists with establishing management processes for the ongoing management of coding integrity and test menu changes. For more information, contact: [capsts@cap.org](mailto:capsts@cap.org).
3. There is an extensive library of articles and tabulations on provider EHR to laboratory linkage, and related informatics issues, at the CAP TODAY website. If needed, older articles are available from CAP staff, including the first articles on Interface Engines (1992) and on Provider-Laboratory-Links ("middleware")(1994):[www.cap.org](http://www.cap.org) (CAP TODAY link at bottom of page.)