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Feature

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The Impact of Specimen Rejections

Mayo Medical Laboratories (MML) is committed to high-quality patient care. As part of that care, MML carefully evaluates each specimen received for condition and suitability for analysis. Specimen rejections and reporting delays cause patient and physician dissatisfaction, cost time and money, and in many cases may impact patient care. In this issue, we discuss the impact of preanalytic errors such as improper specimens, mislabeling, or mispackaging, and we describe the steps MML takes to correct or reduce the impact of such errors.

Focus on Patients

Redraws/recollections, even if possible, require the patient to return to the collection site and undergo another collection effort or procedure. At best, recollecting is annoying and generates additional costs. At worst, it may expose patients to unpleasant or high-risk collection procedures. Specimen rejection/specimen failure also can result in delayed treatments or loss of irreplaceable, critical diagnostic information.

Rather than automatically rejecting a specimen that falls outside the identified specifications, Mayo staffs go to great lengths to salvage those specimens that can be appropriately tested. Specimens that do not meet our prescribed collection and transportation criteria are carefully evaluated to determine whether they can be safely and accurately tested to provide you with a valid result. This effort helps reduce the number of redraws and recollections.

Specimen Evaluation

Specimen Transport and Arrival

Specimens may be rejected for a multitude of reasons. Anything from improper labeling, incorrect patient information, wrong tube type, wrong specimen type, inappropriate specimen transport temperature, and wrong test ordered can result in a rejected specimen. At MML, we conduct a multistage evaluation, beginning as soon as the specimen is handed to a Mayo courier or received at the Mayo receiving area.

A visual inspection is performed to ensure that the specimen is properly packaged and that specimens have not been damaged in transit.

MML utilizes color-coded packaging materials to speed the visual review. Bags for ambient specimens have a white background, refrigerated bags have a pink background, and frozen bags have a yellow background. With the use of color-coded specimen bags, it is easy for couriers and staff to verify that the appropriate materials were used in packaging. Additionally, color coding helps accessioning personnel quickly determine if the specimen was received at the appropriate temperature and sort the incoming specimens into appropriate temperature groups for processing. When items are packaged in other materials, this inspection is still performed but may take slightly longer.

MML provides an extensive range of collection and transport supplies to assist clients in properly preparing their specimens for shipment. These supplies have been rigorously tested by MML for their ability to properly contain and protect specimens under a wide range of conditions. Mayo Laboratory Inquiry (MLI), our customer service center, is available 24 hours a day, 7 days a week to answer any questions you may have about specimen collection, preparation, packaging, transport, and testing.

Accessioning

Once specimens enter the accessioning process at MML, the lab assistant matches the paperwork to the specimen and begins a rapid evaluation of the physical condition of the specimen. Evaluation for patient demographics, specimen type, test requirements, and temperature conditions are just part of the initial evaluation that every specimen receives. Once the accessioners have completed their work, the specimens are transported via a robotic transport to the Sort/Send area, which utilizes an electronic transport vehicle (ETV) to rapidly deliver specimens to the appropriate laboratory.

On average, approximately 3% of the specimens received by MML do not meet our published specimen requirements and require additional attention; these specimens are forwarded to our Exception Handling area. While 3% is not a large percentage, it represents approximately 100,000 specimens per year (MML receives over 3.3 million test requests annually). Fortunately, as a result of ongoing training and experience, 15-20% of these are quickly resolved by our Exception Handling staff and do not require contacting the client. For the remaining 80-85%, a call is placed to the client to help resolve the question or gather the information needed. Virtually all special handling situations (95%) are communicated to our clients within 2 hours of receipt, ensuring rapid resolution. In addition to problematic specimens, calls are placed to clients to resolve patient identification questions and collect missing information that may be essential to a proper interpretation of test results. In 2002, MML placed 109,929 calls to clients, averaging over 300 per day.

While we question about 3% of the specimens we receive, the actual number of specimens rejected at MML is much lower, averaging 0.08%. Part of the reason this number is so low is that we go to great lengths to salvage specimens so that patients are not subjected to additional procedures, and also because many specimens cannot be recollected.

Specimen Suitability

After our initial review, our Exception Handling staff will reject certain specimens because the specimen is readily deemed unsuitable for testing. These are situations where our laboratory experts have already determined that the results are unreliable or misleading if the guidelines have not been followed. However, some tests can be run in spite of specimens being in less-than-optimal condition. Whenever there is a possibility of salvaging a problem specimen, calls are made to the appropriate Mayo laboratory to determine the suitability of the specimen for testing.

When an inappropriate condition does not necessarily preclude analysis, the laboratory is notified of any less-than-optimum parameters, and the specimen moves to the specific laboratory for a closer evaluation by the

personnel who actually perform the test. In appropriate situations, the test may be run with full knowledge that the specimen was not in ideal condition with the understanding that a result could provide clinically useful information. For example, an assay to identify low levels of a specific enzyme, may still be performed, even if the results are not “valid” for determining the actual level of enzyme. If a low result is diagnostic for a specific disease, the results may be informative. If reduced levels are found, the result is not reported because it is not possible to know if the result was inherent in the original specimen or if the enzyme degraded in transit. With the oversight of a pathologist, this strategy can be utilized to salvage a specimen that is difficult to obtain, such as a pediatric specimen. With our pathologists’ input, we can identify those tests that can still provide useful results.

Mayo’s Test Validation Process

The decision to run suboptimal specimens is possible because Mayo laboratories perform extensive validation studies prior to all new test implementation. These method validation studies include determination of appropriate (and inappropriate) specimen types and stability at room, refrigerated, and frozen temperatures for 7 days. This information allows us to better determine the effect that nonstandard specimen states may have on a given result and to decide whether such a specimen can be salvaged and still provide a valid result.

Conclusion

In the interest of quality, and to reduce the time and effort required to troubleshoot problem specimens, we urge all clients to adhere to the defined specimen collection, processing, and transportation requirements. MLI is available around the clock to assist you with your collection and packaging needs at 800-533-1710.

However, when specimens that do not meet our test parameters are received, we will take the time to evaluate each specimen and determine whether valuable and valid information can be generated. In this manner, we continue our commitment to quality patient care and a patient focus in our reference laboratory services.

Examples of Common Accessioning Problems

Condition: Inappropriate Transport Temperature

Frozen blood specimen for congenital chromosome analysis is received.

Outcome: Rejection

Specimen is rejected in Accessioning. Chromosome analysis requires living cells to culture and freezing kills the cells.

Condition: Clots

Blood specimen for congenital chromosome analysis is received. Specimen has developed clots.

Outcome: Attempted Analysis

Clotting traps the cells in the clot, making them unavailable for analysis. However, on the chance that not all cells are trapped in the clot, the laboratory will attempt to grow cells from the specimen and avoid having the patient redrawn. The specimen is not rejected. If the test is successful, results are reported. If unsuccessful, the report identifies the problem with the specimen condition.

Condition: Wrong Tube Type

Serum specimen for molybdenum (or other metals analysis) is received in an SST tube.

Outcome: Rejection

Accessioning rejects specimen. The methods employed in the Metals Laboratory at Mayo detect many metals at the sub-parts-per-billion concentration range and contamination from the specimen collection process is a critical problem. The Metals Laboratory has evaluated numerous specimen collection containers and established that most of these containers introduce significant contaminations. For this reason, MML only

tests specimens collected in accordance with their instructions and in the royal blue-top Monoject Trace Element Blood Collection Tube, product number 8881-307006 (Supply T184) and shipped in a 7.0-mL, Mayo metal-free, screw-capped, polypropylene vial (Supply T173).

Condition: Broken tube

Specimen arrives in a broken tube.

Outcome:

This situation is highly variable and depends entirely upon the packaging that was utilized, the amount of specimen that may be salvageable, and the test requested. Each specimen is individually examined.

Condition: Missing Patient Information

A specimen received for Tay-Sachs analysis arrives without the appropriate paperwork.

Outcome: Test Performed – Results Held for Missing Interpretation

When specimens are received for many of our genetic tests, MML requires the specimen be accompanied by additional information forms. The additional information is needed to appropriately interpret the test results. For example, for Tay-Sachs testing an interpretation may not be possible when the ethnic background and family history are not provided. When the requested information is not provided, MML personnel must try to contact the client and collect the information. This slows the testing process. However, to ensure that testing is performed on a viable specimen, the laboratory promptly performs the test but defers interpreting the results until the necessary information is received.

Galactose-1-Phosphate Reporting Change

Galactose-1-phosphate (G-1-P) is utilized to monitor dietary therapy for classic galactosemia (galactose-1-phosphate uridylyltransferase [GPUT] deficiency), Duarte variant galactosemia, or patients with uridine diphosphate (UDP) galactose-4-epimerase (GALE) deficiency. Mayo's stated reference range for [#80337 Galactose-1-Phosphate \(G-1-P\), Erythrocytes](#) is in μg G-1-P/g of hemoglobin (Hgb). To assist physicians in long-term monitoring of their patients, results now include an interpretive comment that converts the results from μg G-1-P/g Hgb to mg/dL using the specimen-specific hemoglobin value.

Syphilis IgG and IgM Test Changes

Reagents have been unavailable for the syphilis IgM test for an extended period. As a result, Mayo has deleted IgM from [#81814](#) and changed the name to [Syphilis IgG, Serum](#). Positive IgG results by enzyme immunoassay (EIA) are automatically reflexed to a rapid plasmin reagin (RPR) test at no additional charge. The removal of IgM from the test also impacts the reference values.

[New Reference Values](#)

IgG: Negative

RPR: Negative

[Previous Reference Values](#)

IgG: Negative

RPR: Nonreactive

IgM: (was not reported)

Mayo Medical Laboratories First to Launch New Blood Test to Assess Risk for Coronary Events

Mayo Medical Laboratories is the first clinical laboratory to offer testing for lipoprotein-associated phospholipase (Lp-PLA2). Lp-PLA2 is an enzyme found in human blood and arterial plaques, which has been identified as a strong independent predictor for cardiac events.

Lp-PLA2 was previously described as a novel risk factor for cardiac events in a paper published in the *New England Journal of Medicine* (Oct. 19, 2000). In this study, individuals with elevated levels of Lp-PLA2 had as much as a 2-fold elevated risk for coronary heart disease. In addition, Lp-PLA2 was independently predictive of those at risk when compared to both traditional risk factors, such as low-density lipoprotein (LDL) cholesterol, and markers of systemic inflammation, such as C-reactive protein (CRP).

On April 2, 2003, in a late-breaking news session at the American College of Cardiology's 52nd Annual Scientific Session, Dr. Christie Ballantyne presented the results of Lp-PLA2 analysis in the Atherosclerosis Risks in Communities (ARIC) study population. In a case-cohort study involving 609 patients with incident coronary heart disease and 741 controls, the

investigators found that Lp-PLA2 was independently associated with incident coronary heart disease in patients with LDL below 130 mg/dL. This association was upheld, even after adjustment for age, sex, race, smoking, blood pressure, diabetes, LDL, HDL, and CRP. Additionally, individuals with LDL <130 mg/dL may not normally be identified for intervention. In the ARIC population, this group constituted one third of all CHD events. In this <130 mg/dL population, elevated levels of either Lp-PLA2 or hs-CRP identified individuals with an increased CHD risk. Increased levels of both Lp-PLA2 and hs-CRP predicted those at an even greater risk for a coronary event.

Lp-PLA2, like other tests offered by Mayo to measure the emerging risk markers (homocysteine, lipoprotein (a), and CRP) may be used as an adjunct to adjust the estimate of risk determined with the major risk factors. As with other emerging risk markers, Lp-PLA2 may be most appropriately measured in those judged to be at intermediate risk by Framingham scoring, to help guide the intensity of risk reduction therapy. Analysis may be particularly helpful in patients with LDL cholesterol <130 mg/dL.

Coronary Heart Disease Risk Ratio by Lp-PLA2 tertile: ARIC

	Lp-PLA2: 2nd tertile (310-420 µg/L)	Lp-PLA2: 3rd tertile (≥ 420 µg/L)
LDL <130 mg/dL Without CRP adjustment	1.81 (1.10-2.97)	2.02 (1.19-3.44)
LDL <130 mg/dL With CRP adjustment	1.81 (1.08-3.01)	2.12 (1.22-3.69)

Coronary Heart Disease Risk for Lp-PLA2 and CRP: ARIC

	Lp-PLA2 < 420 µg/L	Lp-PLA2 ≥ 420 µg/L
CRP >3.0 mg/L	1.1	3.1
CRP ≤3.0 mg/L	1.0	1.0

Cystic Fibrosis Testing Update

Cystic fibrosis (CF) is one of the most common autosomal recessive disorders in the Caucasian population, with a carrier rate of approximately 1 in 25. Although CF affects multiple organ systems, the major morbidity and mortality are due to the pulmonary disease. The gene responsible for CF, the cystic fibrosis transmembrane conductance regulator (CFTR), was identified in 1989.¹⁻³ At that time, it was determined that the majority of abnormal chromosomes seen in CF bore a single mutation, a 3 base pair deletion that leads to the deletion of a single phenylalanine residue at position 508 of the mature CFTR protein. This mutation, termed $\Delta F508$, accounts for approximately 70% of mutations in the North American CF population. In the years since the original description of the gene, investigators worldwide have identified many additional CFTR mutations. Currently, over 1,000 disease-associated mutations have been identified and are catalogued in a Web-accessible database at the Hospital for Sick Children at the University of Toronto (<http://www.genet.sickkids.on.ca/cftr/>).

Due to the enormous success of Tay-Sachs carrier screening programs in reducing the incidence of this lethal, infantile onset disorder,⁴ there has been significant interest in developing broad, population-based carrier screening programs for CF. Because no currently available biochemical test can reliably detect CF carrier status, such a program would rely on DNA testing. However, the American Society of Human Genetics recommended in 1992 that such a screening program not be implemented until at least 90% of CF mutations were identified. In 1997, a National Institutes of Health (NIH) Consensus Panel recommended that CF carrier screening should be offered to all Caucasian couples planning a pregnancy or seeking prenatal care, in addition to couples in whom one or both partners had a family history of CF. In 2001, the American College of Medical Genetics and the American College of Obstetrics and Gynecology, in conjunction with the National Human Genome Research Institute, released a joint statement that defined and recommended a DNA-based screening panel for implementation in the United States. The panel was composed of 25 CFTR mutations that, together, accounted for 90% of CF mutations in persons of Northern European heritage.⁵ The mutation panel was selected to contain mutations that had an allele frequency of $>0.1\%$ in the American population. In addition, mutations that are more common in certain ethnic groups, that also have a frequency of $\geq 0.1\%$ in the general population, were included in the recommended panel.

Update on the I148T Mutation

One of the mutations on the recommended panel is I148T. This mutation is a cytosine (C) to thymine (T) point mutation that leads to the substitution of an isoleucine for the normal threonine at position 148 of the CFTR protein. This mutation has been reported to account for 9% of CF chromosome mutations in the French Canadian population and was selected for inclusion in the panel on this basis. Recently, publications from several laboratories with large screening programs have identified inconsistencies in the number of I148T alleles identified in carrier screens versus individuals with a diagnosis of CF. Strom et al reported that in the first 20,000 CF screening samples the I148T mutation was found in 64 individuals and that this mutation accounted for 7.7% of all CF mutations identified. This high frequency was contrasted with an I148T frequency of only 0.068% in individuals affected with CF.⁶ The 113-fold increase in the prevalence of the I148T allele in carriers versus affected individuals leads the authors to speculate that I148T may not be a disease-causing mutation, but instead is a benign polymorphism or very mild allele with incomplete penetrance. This conclusion was buttressed by the finding of 2 asymptomatic individuals with the genotype $\Delta F508/I148T$.⁶ Rohlfs et al also reported a greater than 100-fold discrepancy between the allele frequency of I148T in carriers versus affected individuals.⁷

The Genzyme Genetics group, in collaboration with investigators from the University of North Carolina, identified the reasons for the discrepancy. After complete gene sequencing, these investigators found a second mutation, a 6 base pair deletion at position 3199 of the messenger RNA (3199del6) in several symptomatic patients with 1 known CF mutation and the I148T allele.⁷ Testing of 7 asymptomatic individuals, 6 with the $\Delta F508/I148T$ genotype and 1 I148T homozygote, showed that none of them carried the 3199del6 mutation in cis (ie, on the same chromosome) as the I148T allele. Further testing for the presence of the 3199del6 in 90 specimens that had tested positive for the I148T allele revealed that only 2 of the 90 individuals carried the deletion mutation. The investigators concluded that the I148T allele is not a CF mutation, rather it is a polymorphism that, in some cases, serves as a marker for the presence of a second, disease-associated mutation (3199del6). This 3199del6 allele is not detected by the current commercially available CF testing platforms.

– Continued

Reflex Testing for 3199del6 at Mayo

Molecular CF testing was initiated at Mayo in 1990, and I148T has been included in the Mayo panel since its inception. Since that time, we have observed 60 cases in which an individual tested positive for this alteration. After the publication of the paper by Rohlfs et al, these specimens were retrieved and analyzed for the presence of the 3199del6 mutation. We confirmed the observations of Rohlfs et al that only a minority of chromosomes bearing the I148T allele also carry the 3199del6 mutation. In the Mayo series, of the 60 specimens submitted for CF carrier screening that had previously tested positive for I148T, there were only 2 individuals who carried the 3199del6 mutation and were, therefore, carriers of CF. As a result of these findings, the Mayo Molecular Genetics Laboratory has instituted a reflex test, at no additional cost to the patient, for the 3199del6 mutation whenever a specimen tests positive for I148T. If the reflex test is negative (ie, if the 3199del6 mutation is not identified), the interpretive report will give the I148T result, but based on the negative 3199del6 result, will state that the individual is not considered a CF carrier. Alternatively, if the reflex test is positive (ie, the 3199del6 mutation is detected), the interpretive report will indicate that the individual is a carrier of CF.

Follow-up Testing

Diagnosis as a carrier of CF has significant implications for the patient and genetic counseling is strongly recommended. Because the presence of the I148T mutation alone has previously been identified with carrier status, it is important that patients who were diagnosed in the past as carriers with the I148T mutation be reevaluated for the presence of both the I148T and 3199del6 mutations. Patients who were tested at Mayo since 1990 were already reevaluated and their physicians have been contacted about their true carrier status. However, for patients who were not tested at Mayo, physicians should consider having patients previously identified as carriers of I148T evaluated for the presence or absence of 3199del6. If you have any questions about carrier testing for CF, you can speak to a genetic counselor at Mayo by calling 800-533-1710.

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B-Type Natriuretic Peptide (BNP) Range Change

Due to reagent reformulation, the upper limit of detection for **#13020 B-Type Natriuretic Peptide (BNP), Blood** has been extended from 1300 pg/mL to 4000 pg/mL.

Whipple's Disease Test Changes

The test for *Tropheryma whipplei*, **#80909 Whipple's Disease Associated Bacillus (*Tropheryma whipplei*) DNA Detection by Polymerase Chain Reaction (PCR)**, was changed from a conventional PCR method to rapid PCR utilizing Lightcycler™ technology. As a result, the name of the test has been changed to **#80909 *Tropheryma whipplei* by Rapid PCR** and the test analytic time has been reduced from 2-3 days to 1 day (paraffin blocks – 2 days). Previously performed on Wednesdays, specimens will now be run on Tuesdays; paraffin block processing will be performed on Mondays with the specimen analyzed on Tuesdays.

Troponin T Reference Value Change

The presence of any detectable level (>0.01 ng/mL) of troponin T (cTnT) has been shown to have significance in patients with ischemic heart disease. However, currently available analytical methods for measuring cTnT are not very precise at very low levels (0.01-0.03 ng/mL). Thus, the designated upper limit of the reference range for **#82428 Troponin T, Serum** has been adjusted from <0.1 to <0.03 ng/ml. Although 0.03 ng/mL is not the true upper limit for normal individuals, it is the upper limit at which measurement can be performed with confidence. The flagging of this value should not preclude a clinician from suggesting the importance of lower values in an individual patient. It simply means he/she does so while cognizant of the risk that the value is due to analytic imprecision.

Propoxyphene (Serum) Test Changes

The method for #8353, [Propoxyphene, Serum](#), was changed from gas-liquid chromatography (GLC) to gas chromatography/mass spectrometry (GC/MS). With this change, the test now detects norpropoxyphene, the primary metabolite of propoxyphene.

New Reference Values

Propoxyphene: 0.2-0.5 µg/mL

Norpropoxyphene: 0.1-0.7 µg/mL

Previous Reference Values

Therapeutic concentration: 0.2-0.5 µg/mL

Toxic concentration: >1.0 µg/mL

Hepatitis C Virus Quantitation Reporting Changes

#83145 [Hepatitis C Virus \(HCV\) Quantitation by Reverse Transcription-Polymerase Chain Reaction \(RT-PCR\), Serum](#) previously reported results in both international unit (IU)/mL and log¹⁰. To minimize confusion, the log¹⁰ results have been deleted from the report.

The report also has been modified to include the linear range of the assay (600-500,000 IU/mL) and the conversion factor (2.7) for converting IU/mL to copies/mL.

Osmotic Fragility Reference Value Changes

A normal value study performed at Mayo has resulted in changes to the reference values for #9064 [Osmotic Fragility, Erythrocytes](#).

New Reference Values

0.5 g/dL NaCl (unincubated)

Males: 0.0-47.8% hemolysis

Females: 0.0-31.1% hemolysis

0.6 g/dL NaCl (incubated)

Males: 18.7-67.4% hemolysis

Females: 10.9-65.5% hemolysis

0.65 g/dL NaCl (incubated)

Males: 4.4-36.6% hemolysis

Females: 0.2-39.3% hemolysis

0.75 g/dL NaCl (incubated)

Males: 0.8-9.1% hemolysis

Females: 0.0-10.9% hemolysis

Previous Reference Values

0.50 g/dL NaCl (unincubated)

Males: 0.5-24.7% hemolysis

Females: 0.0-23.1% hemolysis

0.6 g/dL NaCl (incubated)

Males: 18.0-55.2% hemolysis

Females: 2.2-59.3% hemolysis

0.65 g/dL NaCl (incubated)

Males: 4.0-24.8% hemolysis

Females: 0.5-28.9% hemolysis

0.75 g/dL NaCl (incubated)

Males: 0.5-8.5% hemolysis

Females: 0.1-9.3% hemolysis

FISH Requirements for Paraffin Specimens

Fluorescent in situ hybridization (FISH) testing utilizes highly specific probes to identify various chromosomal changes. For this reason, it is essential to match each specimen to the appropriate FISH probes for the suspected diagnosis. To improve patient care and avoid inappropriate testing, the laboratory evaluates each paraffin-embedded specimen based on the information provided in the pathology report. When a pathology report is not provided, the laboratory must contact the client to verify the suspected diagnosis and clinical information. Effective immediately, all paraffin-embedded specimens submitted for the following tests must be accompanied by a pathology report:

#80029 [Fluorescence In Situ Hybridization \(FISH\) for 1p/19q Deletion in Gliomas](#)

#81954 [Fluorescence In Situ Hybridization \(FISH\) for Detection of HER-2/neu Amplification Associated with Breast Cancer](#)

#81006 [Interphase Fluorescence In Situ Hybridization \(FISH\) Analysis for Molar Pregnancy](#)

Protein Electrophoresis (Urine) Specimen Requirements Change

The specimen requirements have been changed for the following tests:

#82441 [Protein Electrophoresis, Urine](#)

#8823 [Monoclonal Protein Study, Urine](#)

New Specimen Requirement

50 mL from a 24-hour urine collection. No preservative. Aliquot specimen between 1 plastic, 60-mL urine bottle and 1 plastic, 13-mL urine tube and send refrigerated.

Although a 24-hour specimen is recommended, a random specimen will be tested if sent. See "Urine Preservatives" in Special Instructions for multiple collections.

NOTE:

1. If serum M-protein type is known (for monoclonal protein), please indicate on request form.
2. Patient's age and 24-hour volume are required on request form for processing.

2003 Meeting Calendar

Interactive Satellite Programs . . .

Seronegative Spondyloarthropathies: Review and Recent Advances

September 16, 2003

Presenters: Nisha Manek, MD & Clement Michet, Jr, MD
Moderator: Steven Ytterberg, MD

Pharmacogenetics and Pharmacogenomics of Antidepressants

October 7, 2003

Presenters: John Black, MD
David Mrazek, MD
Elliott Richelson, MD
Moderator: Robert Kisabeth, MD

Pharmacogenomics of Warfarin Therapy

November 11, 2003

Presenter: John Heit, MD
Moderator: Robert Kisabeth, MD

Cardiac Markers

December 2, 2003

Presenter: Allan Jaffe, MD
Moderator: Robert Kisabeth, MD

Upcoming Education Conferences . . .

Practical Surgical Pathology

September 11-13, 2003

Mayo Clinic, Siebens Building
Rochester, Minnesota

Integration Through Community Laboratory

Insourcing: Implementing a Successful Laboratory Program

October 8-10, 2003

Providence Marriott Hotel
Providence, Rhode Island



For a complete listing of all the courses offered throughout the year, contact the Mayo Reference Services Education Office at 1-800-533-1710 or 507-284-8742.

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