

Twenty-Five Things Physicians and Patients Should Question

1

Don't perform population based screening for 25-OH-Vitamin D deficiency.

Vitamin D deficiency is common in many populations, particularly in patients at higher latitudes, during winter months and in those with limited sun exposure. Over the counter Vitamin D supplements and increased summer sun exposure are sufficient for most otherwise healthy patients. Laboratory testing is appropriate in higher risk patients when results will be used to institute more aggressive therapy (e.g., osteoporosis, chronic kidney disease, malabsorption, some infections, obese individuals).

2

Don't perform low risk HPV testing.

National guidelines provide for HPV testing in patients with certain abnormal Pap smears and in other select clinical indications. The presence of high risk HPV leads to more frequent examination or more aggressive investigation (e.g., colposcopy and biopsy). There is no medical indication for low risk HPV testing (HPV types that cause genital warts or very minor cell changes on the cervix) because the infection is not associated with disease progression and there is no treatment or therapy change indicated when low risk HPV is identified.

3

Avoid routine preoperative testing for low risk surgeries without a clinical indication.

Most preoperative tests (typically a complete blood count, Prothrombin Time and Partial Prothomboplastin Time, basic metabolic panel and urinalysis) performed on elective surgical patients are normal. Findings influence management in under 3% of patients tested. In almost all cases, no adverse outcomes are observed when clinically stable patients undergo elective surgery, irrespective of whether an abnormal test is identified. Preoperative testing is appropriate in symptomatic patients and those with risks factors for which diagnostic testing can provide clarification of patient surgical risk.

4

Only order Methylated Septin 9 (SEPT9) to screen for colon cancer on patients for whom conventional diagnostics are not possible.

Methylated Septin 9 (SEPT9) is a plasma test to screen patients for colorectal cancer. Its sensitivity and specificity are similar to commonly ordered stool guaiac or fecal immune tests. It offers an advantage over no testing in patients that refuse these tests or who, despite aggressive counseling, decline to have recommended colonoscopy. The test should not be considered as an alternative to standard diagnostic procedures when those procedures are possible.

5

Don't use bleeding time test to guide patient care.

The bleeding time test is an older assay that has been replaced by alternative coagulation tests. The relationship between the bleeding time test and the risk of a patient's actually bleeding has not been established. Further, the test leaves a scar on the forearm. There are other reliable tests of coagulation available to evaluate the risks of bleeding in appropriate patient populations.

Twenty-Five Things Physicians and Patients Should Question

6

Don't order an erythrocyte sedimentation rate (ESR) to look for inflammation in patients with undiagnosed conditions. Order a C-reactive protein (CRP) to detect acute phase inflammation.

CRP is a more sensitive and specific reflection of the acute phase of inflammation than is the ESR. In the first 24 hours of a disease process, the CRP will be elevated, while the ESR may be normal. If the source of inflammation is removed, the CRP will return to normal within a day or so, while the ESR will remain elevated for several days until excess fibrinogen is removed from the serum.

7

Don't test vitamin K levels unless the patient has an abnormal international normalized ratio (INR) and does not respond to vitamin K therapy.

Measurements of the level of vitamin K in the blood are rarely used to determine if a deficiency exists. Vitamin K deficiency is very rare, but when it does occur, a prolonged prothrombin time (PT) and elevated INR will result. A diagnosis is typically made by observing the PT correction following administration of vitamin K, plus the presence of clinical risk factors for vitamin K deficiency.

8

Don't prescribe testosterone therapy unless there is laboratory evidence of testosterone deficiency.

With the increased incidence of obesity and diabetes, there may be increasing numbers of older men with lower testosterone levels that do not fully meet diagnostic or symptomatic criteria for hypogonadism. Current clinical guidelines recommend making a diagnosis of androgen deficiency only in men with consistent symptoms and signs coupled with unequivocally low serum testosterone levels. Serum testosterone should only be ordered on patients exhibiting signs and symptoms of androgen deficiency.

9

Don't test for myoglobin or CK-MB in the diagnosis of acute myocardial infarction (AMI). Instead, use troponin I or T.

Unlike CK-MB and myoglobin, the release of troponin I or T is specific to cardiac injury.

Troponin is released before CK-MB and appears in the blood as early as, if not earlier than, myoglobin after AMI. Approximately 30% of patients experiencing chest discomfort at rest with a normal CK-MB will be diagnosed with AMI when evaluated using troponins. Single-point troponin measurements equate to infarct size for the determination of the AMI severity. Accordingly, there is much support for relying solely on troponin and discontinuing the use of CK-MB and other markers.

10

Don't order multiple tests in the initial evaluation of a patient with suspected non-neoplastic thyroid disease. Order thyroid-stimulating hormone (TSH), and if abnormal, follow up with additional evaluation or treatment depending on the findings.

The TSH test can detect subclinical thyroid disease in patients without symptoms of thyroid dysfunction. A TSH value within the reference interval excludes the majority of cases of primary overt thyroid disease. If the TSH is abnormal, confirm the diagnosis with free thyroxine (T4).

Twenty-Five Things Physicians and Patients Should Question

11

Do not routinely perform sentinel lymph node biopsy or other diagnostic tests for the evaluation of early, thin melanoma because these tests do not improve survival.

Sentinel lymph node biopsy (SLNB) is a minimally invasive staging procedure developed to identify patients with subclinical nodal metastases at higher risk of occurrence, who could be candidates for complete lymph node dissection or adjuvant systemic therapy. The National Comprehensive Cancer Network (NCCN) Melanoma Panel does not recommend SLNB for patients with in situ melanoma (stage 0). In general, the panel does not recommend SLNB for Stage 1A or 1B lesions that are very thin (0.75mm or less). In the rare event that a conventional high-risk feature is present, the decision about SLNB should be left to the patient and the treating physician.

12

Do not routinely order expanded lipid panels (particle sizing, nuclear magnetic resonance) as screening tests for cardiovascular disease.

A standard lipid profile includes total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, and triglycerides. These lipids are carried within lipoprotein particles that are heterogeneous in size, density, charge, core lipid composition, specific apolipoproteins, and function. A variety of lipoprotein assays have been developed that subfractionate lipoprotein particles according to some of these properties such as size, density or charge. However, selection of these lipoprotein assays for improving assessment of risk of cardiovascular disease and guiding lipid-lowering therapies should be on an individualized basis for intermediate to high-risk patients only. They are not indicated for population based cardiovascular risk screening.

Research evaluating the frequency and correlates of repeat lipid testing in patients with CHD demonstrates that individuals with LDL-C levels of less than 100mg/dl had no additional benefit from the intensification of lipid-lowering therapies. Understanding the frequency and correlates of redundant lipid testing could identify areas for quality improvement initiatives aimed at improving the efficiency of cholesterol care in patients with coronary heart disease (CHD).

Millions of U.S. adults are at increased ASCVD risk—some because they have had an ASCVD event, others because of ASCVD risk factors. Adherence to healthy lifestyle behaviors, control of blood pressure and diabetes, and avoidance of smoking is recommended for all adults. Statin therapy should be used to reduce ASCVD risk in individuals likely to have a clear net benefit (those with clinical ASCVD) or in primary prevention for adults with LDL-C levels over 190 mg/dL, those aged 40 to 75 years with diabetes, and those with a 10-year ASCVD risk 7.5% without diabetes. A clinician–patient discussion that considers potential ASCVD risk reduction, adverse effects, and patient preferences is needed to decide whether to initiate statin therapy, especially in lower-risk primary prevention.

13

Do not test for amylase in cases of suspected acute pancreatitis. Instead, test for lipase.

Amylase and lipase are digestive enzymes normally released from the acinar cells of the exocrine pancreas into the duodenum. Following injury to the pancreas, these enzymes are released into the circulation. While amylase is cleared in the urine, lipase is reabsorbed back into the circulation. In cases of acute pancreatitis, serum activity for both enzymes is greatly increased.

Serum lipase is now the preferred test due to its improved sensitivity, particularly in alcohol-induced pancreatitis. Its prolonged elevation creates a wider diagnostic window than amylase. In acute pancreatitis, amylase can rise rapidly within 3–6 hours of the onset of symptoms and may remain elevated for up to five days. Lipase, however, usually peaks at 24 hours with serum concentrations remaining elevated for 8–14 days. This means it is far more useful than amylase when the clinical presentation or testing has been delayed for more than 24 hours.

Current guidelines and recommendations indicate that lipase should be preferred over total and pancreatic amylase for the initial diagnosis of acute pancreatitis and that the assessment should not be repeated over time to monitor disease prognosis. Repeat testing should be considered only when the patient has signs and symptoms of persisting pancreatic or peripancreatic inflammation, blockage of the pancreatic duct or development of a pseudocyst. Testing both amylase and lipase is generally discouraged because it increases costs while only marginally improving diagnostic efficiency compared to either marker alone.

Twenty-Five Things Physicians and Patients Should Question

14

Do not request serology for *H. pylori*. Use the stool antigen or breath tests instead.

Serologic evaluation of patients to determine the presence/absence of *Helicobacter pylori* (*H. pylori*) infection is no longer considered clinically useful. Alternative noninvasive testing methods (e.g., the urea breath test and stool antigen test) exist for detecting the presence of the bacteria and have demonstrated higher clinical utility, sensitivity, and specificity. Additionally, both the American College of Gastroenterology and the American Gastroenterology Association recommend either the breath or stool antigen tests as the preferred testing modalities for active *H. pylori* infection. Finally, several laboratories have dropped the serological test from their menus, and many insurance providers are no longer reimbursing patients for serologic testing.

15

Do not perform fluorescence in situ hybridization (FISH) for myelodysplastic syndrome (MDS)-related abnormalities on bone marrow samples obtained for cytopenias when an adequate conventional karyotype is obtained.

The presence of certain clonal abnormalities in the bone marrow or blood of patients with cytopenia(s) establishes or strongly supports the diagnosis of MDS, in some cases even in the absence of diagnostic morphologic findings. MDS FISH panels typically employ probes for four or more genetic loci, making this an expensive test. Multiple studies have demonstrated the added value of MDS FISH on bone marrow is extremely low when a satisfactory karyotype is obtained (20 interpretable metaphases). MDS FISH can be performed post hoc in the event of an unsatisfactory karyotype.

16

Do not order a frozen section on a pathology specimen if the result will not affect immediate (i.e., intraoperative or perioperative) patient management.

Although the result of an intraoperative frozen section evaluation is often helpful to determine the treatment path of a patient during a surgical procedure, the frozen section analysis may be limited in regards to sampling and technical issues that can hinder interpretation and/or compromise the integrity of the specimen for the final diagnosis. If there is no therapeutic decision to be made for the patient on the day of the surgical procedure based on the results of the frozen section, it is preferable to submit the specimen for routine (or rush, if necessary) histologic processing and permanent section evaluation.

17

Do not repeat hemoglobin electrophoresis (or equivalent) in patients who have a prior result and who do not require therapeutic intervention or monitoring of hemoglobin variant levels.

Pre-conception and antenatal hemoglobin electrophoresis screening is recommended, especially in high prevalence areas for sickle cell disease or thalassemia, and has become routine practice in order to detect abnormalities of hemoglobins S, C, D-Punjab, E, O-Arab, Lepore, beta-thalassemia trait, delta/beta thalassemia trait, alpha thalassemia trait (2 chain deletion), and hereditary persistence of fetal hemoglobin (HPFH). Partner testing should be offered when there is a risk of a significant hemoglobinopathy in the infant. Repeat hemoglobin electrophoresis testing is required only to make a more specific diagnosis or monitor the results of interventional therapies in patients with known hemoglobinopathies. Providers should investigate prior results before requesting a repeat hemoglobin electrophoresis.

Twenty-Five Things Physicians and Patients Should Question

18

Do not test for Protein C, Protein S, or Antithrombin (ATIII) levels during an active clotting event to diagnose a hereditary deficiency because these tests are not analytically accurate during an active clotting event.

These assays may be useful to test for an acquired deficiency (i.e., disseminated intravascular coagulation) in consumptive coagulopathies. These tests are not analytically accurate during an active clotting event. Moreover they are not clinically actionable at the time of an acute clot, because the same therapeutic intervention (anticoagulation) is performed regardless of the results. Deferral to the outpatient/non-acute setting allows for the testing to be done at a time when the results would change patient management, i.e., ceasing or continuing anticoagulation. Because anticoagulation may also impact the determination of results (e.g., Protein C and Protein S decrease on warfarin, while ATIII is actually elevated), testing while on anticoagulants may also yield misleading results and should be avoided.

19

Do not order red blood cell folate levels at all. In adults, consider folate supplementation instead of serum folate testing in patients with macrocytic anemia.

Since 1998, when the U.S. and Canada mandated that foods with processed grains be fortified with folic acid, there has been a significant decline in the incidence of folate deficiency. For the rare patient suspected of having a folate deficiency, simply treating with folic acid is a more cost-effective approach than blood testing. While red blood cell folate levels have been used in the past as a surrogate for tissue folate levels or a marker for folate status over the lifetime of red blood cells, the result of this testing does not, in general, add to the clinical diagnosis or therapeutic plan.

20

Do not use sputum cytology to evaluate patients with peripheral lung lesions.

Sputum cytology is not effective for evaluating peripheral lesions. For peripheral lesion evaluation, consider alternative diagnostic approaches (e.g., image guided needle aspiration).

21

Don't request just a serum creatinine to test adult patients with diabetes and/or hypertension for CKD; use the Kidney Profile (serum Creatinine with eGFR and urinary albumin-creatinine ratio.)

Use the National Kidney Foundation (NKF) updated evidence-based Kidney Profile test to evaluate patients for CKD with the following common tests to more effectively assess kidney function.

- "Spot" urine for albumin-creatinine ratio (ACR) to detect albuminuria
- Serum creatinine to estimate glomerular filtration rate (GFR) using the CKD EPI equation

22

Don't transfuse plasma to correct a laboratory value; treat the clinical status of the patient.

Plasma transfusion to a patient with an INR of <1.6 has minimal effect, and transfusion for INR values between 1.6 and 2 should be carefully considered. Since a mildly elevated INR is usually not associated with spontaneous hemorrhage and doesn't increase the risk of bleeding during routine invasive procedures, excessive transfusion of plasma is unnecessary and increases the risk of transfusion-associated circulatory overload (TACO), which is a leading cause of transfusion associated morbidity and mortality. Judicious use of vitamin K and/or prothrombin complex concentrate following evidence-based clinical practice guidelines should also be considered to avoid unnecessary transfusion.

Twenty-Five Things Physicians and Patients Should Question

23 **Don't order IgM antibody serologic studies to assess for acute infection with infectious agents no longer endemic in the US, and in general avoid using IgM antibody serologies to test for acute infection in the absence of sufficient pre-test probability.**

As the prevalence of a disease decreases, so does the positive predictive value for testing for acute infection with that disease. Although documentation of IgG antibodies to rare infectious agents is useful (for documentation of effective vaccination, for example), assessing acute infection by evaluation of IgM antibody status to these agents is fraught with false positives and low predictive value. For example, according to CDC, rubella is no longer endemic in the US. As such, nearly all positive rubella IgM antibody tests are false positives, resulting in unnecessary follow-up testing and unnecessary anxiety.

Even for diseases not yet eradicated and for which low level outbreaks still occur (such as measles), if overall prevalence remains low, then the predictive value of positive IgM serology will still be low. False positive measles IgM serology, for example, has been documented due to cross-reactivity to parvovirus and human herpes virus 6, among others.

If clinical evaluation yields legitimate pre-test suspicion for a rare infectious disease, then practitioners should report to and engage the help of their state public health department and/or the CDC in further evaluating for potential acute infection.

In common viral infections it is also most effective to limit IgM serology to those cases in which clinical assessment yields relatively high suspicion for acute infection, since there are well known causes for potential IgM antibody cross-reactivity (rheumatoid factor, cross reactivity with other viral antigens). The potential for false positive results will decrease (and positive predictive value will increase) with increasing pre-test probability for true acute infection.

24 **Do not perform peripheral blood flow cytometry to screen for hematological malignancy in the settings of mature neutrophilia, basophilia, erythrocytosis, thrombocytosis, isolated anemia, or isolated thrombocytopenia.**

The role of peripheral blood flow cytometry for hematologic neoplasia is limited to settings in which either there are morphologically abnormal cells identified on a peripheral blood smear review (blasts, lymphoma cells) or there are clinical and/or laboratory findings that suggest a high pre-test probability for the presence of a disorder amenable to the immunophenotypic detection of neoplastic cells in the blood. The latter includes patients with neutropenia, absolute lymphocytosis, lymphadenopathy, or splenomegaly. The likelihood of flow cytometry of blood producing diagnostic results in the settings enumerated in the recommendation above is extremely low; bone marrow sampling with morphologic analysis (and appropriate ancillary diagnostic testing) may be indicated in those scenarios.

25 **Don't perform Procalcitonin testing without an established, evidence-based protocol.**

Procalcitonin is a biomarker that has been used successfully to identify patients with certain bacterial infections (e.g., sepsis). The appropriate use includes serial (usually daily) measurements of procalcitonin in select patient populations (e.g. patients with fever and presumed serious infection for which antibiotics were initiated).(1) Such uses may help to identify low-risk patients with respiratory infections who would not benefit from antibiotic therapy, and to differentiate blood culture contaminants (e.g., coagulase-negative staphylococci) from true infections.(2,3) When used appropriately there are significant opportunities to decrease unnecessary antimicrobial use. The overuse of antimicrobial agents is directly related to the increasing antimicrobial resistance, so judicious use of these agents is warranted.

Unfortunately, procalcitonin is often either misused (i.e. not used in the appropriate setting) or established algorithms are not followed. When the latter occurs, the procalcitonin result becomes simply another piece of laboratory data that adds costs, but does not benefit the patient. These scenarios often occur because there is not an evidence-based utilization plan established at an institution. Laboratory and intensive care unit leadership are encouraged to identify the major users of procalcitonin, to establish guidelines that are most appropriate for the local setting and to monitor use.

How This List Was Created (1–5)

The American Society for Clinical Pathology (ASCP) list was developed under the leadership of the chair of ASCP's Institute Advisory Committee and Past President of ASCP. Subject matter and test utilization experts across the fields of pathology and laboratory medicine were included in this process for their expertise and guidance. The review panel examined hundreds of options based on both the practice of pathology and evidence available through an extensive review of the literature. The laboratory tests targeted in our recommendations were selected because they are tests that are performed frequently; there is evidence that the test either offers no benefit or is harmful; use of the test is costly and it does not provide higher quality care; and, eliminating it or changing to another test is within the control of the clinician. The final list is not exhaustive (many other tests/procedures were also identified and were also worthy of consideration), but the recommendations, if instituted, would result in higher quality care, lower costs, and more effective use of our laboratory resources and personnel.

How This List Was Created (6–10)

The American Society for Clinical Pathology (ASCP) list of recommendations was developed under the leadership of the ASCP Choosing Wisely Ad Hoc Committee. This committee is chaired by an ASCP Past President and comprises subject matter and test utilization experts across the fields of pathology and laboratory medicine. The committee considered an initial list of possible recommendations compiled as the result of a survey administered to Society members serving on ASCP's many commissions, committees, and councils. The laboratory tests targeted in our recommendations were selected because they are tests that are performed frequently; there is evidence that the test either offers no benefit or is harmful; use of the test is costly and it does not provide higher quality care; and eliminating it or changing to another test is within the control of the clinician. Implementation of these recommendations will result in higher quality care, lower costs, and a more effective use of our laboratory resources and personnel.

How This List Was Created (11–15)

The American Society for Clinical Pathology (ASCP) list of recommendations was developed under the leadership of the ASCP Effective Test Utilization Subcommittee. This committee is chaired by an ASCP Past President and comprises subject matter and test utilization experts across the fields of pathology and laboratory medicine. The committee considered an initial list of possible recommendations compiled as the result of a survey administered to Society members serving on ASCP's many commissions, committees, and councils. The laboratory tests targeted in our recommendations were selected because they are tests that are performed frequently; there is evidence that the test either offers no benefit or is harmful (either entirely or in specific clinical situations); use of the test is costly and it does not provide higher quality care; and eliminating it or changing to another test is within the control of the clinician. Implementation of these recommendations will result in higher quality care, lower costs, and a more effective use of our laboratory resources and personnel.

How This List Was Created (16–20)

The American Society for Clinical Pathology (ASCP) list of recommendations was developed under the leadership of the ASCP Effective Test Utilization Steering Committee. This committee is chaired by an ASCP Past President and is comprised of subject matter and test utilization experts across the fields of pathology and laboratory medicine. The committee considered a list of possible recommendations compiled as the result of a survey administered to Society members serving on ASCP's many commissions, committees and councils. In addition, an announcement was made to ASCP's newly formed Advisory Board seeking suggestions for possible recommendations to promote member involvement. The laboratory tests targeted in our recommendations were selected because they are tests that are performed frequently; there is evidence that the test either offers no benefit or is harmful; use of the test is costly and it does not provide higher quality care; and eliminating it or changing to another test is within the control of the clinician. Implementation of these recommendations will result in higher quality care, lower costs and a more effective use of our laboratory resources and personnel.

How This List Was Created (21–25)

The American Society for Clinical Pathology (ASCP) list of recommendations was developed under the leadership of the ASCP Effective Test Utilization Steering Committee. This committee is chaired by an ASCP Past President and is comprised of subject matter and test utilization experts across the fields of pathology and laboratory medicine. The committee considered a list of possible recommendations compiled as the result of a survey administered to Society members serving on ASCP's many commissions, committees and councils. In addition, an announcement was made to ASCP's newly formed Advisory Board seeking suggestions for possible recommendations to promote member involvement. The laboratory tests targeted in our recommendations were selected because they are tests that are performed frequently; there is evidence that the test either offers no benefit or is harmful; use of the test is costly and it does not provide higher quality care; and eliminating it or changing to another test is within the control of the clinician. Implementation of these recommendations will result in higher quality care, lower costs and a more effective use of our laboratory resources and personnel.

ASCPs' disclosure and conflict of interest policy can be found at www.ascp.org.

Sources

1

Sattar N, Welsh P, Panarelli M, Forouchi NG. Increasing requests for vitamin D measurement: Costly, confusing, and without credibility. *Lancet* [Internet]. 2012 Jan 14 [cited 2012 Oct 12];379:95-96.

Bilinski K, Boyages S. The rising cost of vitamin D testing in Australia: time to establish guidelines for testing. *Med J Aust* [Internet]. 2012 Jul 16 [cited 2012 Oct 12];197 (2):90.

Lu CM. Pathology consultation on vitamin D testing: Clinical indications for 25(OH) vitamin D measurement [Letter to the editor]. *Am J Clin Pathol* [Internet]. 2012 May [cited 2012 Oct 12];137:831.

Holick M, Binkely N, Bischoff-Ferrari H, Gordon CM, Hanley DA, Heaney RP, Murad MH, Weaver CM; Endocrine Society. Evaluation, treatment, and prevention of vitamin D deficiency: An Endocrine Society Clinical Practice Guideline. *J Clin Endocrinol Metab* [Internet]. 2011 Jul [cited 2012 Oct 12];96(7):1911-1930.

2

Lee JW, Berkowitz Z, Saraiya M. Low-risk human papillomavirus testing and other non recommended human papillomavirus testing practices among U.S. health care providers. *Obstet Gynecol*. 2011 Jul;118(1):4-13.

Saslow D, Solomon D, Lawson HW, Killackey M, Kulasingam SL, Cain J, Garcia FA, Moriarty AT, Waxman AG, Wilbur DC, Wentzensen N, Downs LS Jr, Spitzer M, Moscicki AB, Franco EL, Stoler MH, Schiffman M, Castle PE, Myers ER; ACS-ASCCP-ASCP Cervical Cancer Guideline Committee. American Cancer Society, American Society for Colposcopy and Cervical Pathology, and American Society for Clinical Pathology Screening Guidelines for the Prevention and early Detection of Cervical Cancer. *Am J Clin Pathol* [Internet]. 2012 May-Jun [cited 2012 Oct 12];137:516-542.

Zhao C, Chen X, Onisko A, Kanbour A, Austin RM. Follow-up outcomes for a large cohort of U.S. women with negative imaged liquid-based cytology findings and positive high risk human papillomavirus test results. *Gynecol Oncol* [Internet]. 2011 Aug [cited 2012 Oct 12];122:291–296.

American Society for Colposcopy and Cervical Pathology. Descriptions of new FDA-approved HPV DNA tests. HPV Genotyping Clinical Update.[Internet]. Frederick (MD): American Society for Colposcopy and Cervical Pathology. 2009. [Cited 2012 Oct 12]. Available from: www.asccp.org/ConsensusGuidelines/HPVGenotypingClinicalUpdate/tabid/5963/Default.aspx.

3

Keay L, Lindsley K, Tielsch J, Katz J, Schein O. Routine preoperative medical testing for cataract surgery. *Cochrane Database of Systematic Reviews*. 2012, Issue 3. Art. No.: CD007293. DOI: 10.1002/14651858.CD007293.pub3.

Katz R, Dexter F, Rosenfeld K, Wolfe L, Redmond V, Agarwal D, Salik I, Goldstein K, Goodman M, Glass PS. Survey study of anesthesiologists' and surgeons' ordering of unnecessary preoperative laboratory tests. *Anesth Analg*. 2011 Jan;112(1).

Munro J, Booth A, Nicholl J. Routine preoperative testing: A systematic review of the evidence. *Health Technol Assessmen*. 1997;1(12).

Reynolds TM. National Institute for Health and Clinical Excellence guidelines on preoperative tests: The use of routine preoperative tests for elective surgery. *Ann Clin Biochem* [Internet]. 2006 Jan [cited 2012 Oct 12];43:13-16.

Capdenat Saint-Martin E, Michel P, Raymond JM Iskandar H, Chevalier C, Petitpierre MN, Daubech L, Amouretti M, Maurette P. Description of local adaptation of national guidelines and of active feedback for rationalizing preoperative screening in patients at low risk from anaesthetics in a French university hospital. *Qual Health Care* [Internet]. 1998 Mar [cited 2012 Oct 12];7:5-11.

4

Rösch T, Church T, Osborn N, Wandell M, Lofton-Day C, Mongin S, Blumenstein BA, Allen JI, Snover D, Day R, Ransohoff DF. Prospective clinical validation of an assay for methylated SEPT9 DNA for colorectal cancer screening in plasma of average risk men and women over the age of 50. *Gut*. 2010;59(suppl III):A307.

Ahluquist DA, Taylor WR, Mahoney DW, Zou H, Domanico M, Thibodeau SN, Boardman LA, Berger BM, Lidgard GP. The stool DNA test is more accurate than the plasma septin 9 test in detecting colorectal neoplasia. *Clin Gastroenterol Hepatol*. [Internet]. 2012 Mar [cited 2012 Oct 12];10(3):272-7.

5

Lehman CM, Blaylock RC, Alexander DP, Rodges GM. Discontinuation of the bleeding time test without detectable adverse clinical impact. *Clin Chem* [Internet]. 2001;47(7) [cited 2012 Oct 12]:1204-1211.

Peterson P, Hayes TE, Arkin CF, Bovill EG, Fairweather RB, Rock WA Jr, Triplett DA, Brandt JT. The preoperative bleeding time test lacks clinical benefit. *Arch Surg* [Internet]. 1998 Feb [cited 2012 Oct 20];133(2):134-139.

Lind SE. The bleeding time does not predict surgical bleeding. *Blood* [Internet]. 1991 Jun [cited 2012 Oct 20]; 77(12):2547-52.

6

Crowson CS, Rahman MU, Matteson EL. Which measure of inflammation to use? A comparison of erythrocyte sedimentation rate and C-reactive protein measurements from randomized clinical trials of golimumab in rheumatoid arthritis. *J Rheumatol*. 2009 Aug;36 (8):1606-10.

Wu AH, Lewandrowski K, Gronowski AM, Grenache DG, Sokoll LJ, Magnani B. Antiquated tests within the clinical pathology laboratory. *Am J Manag Care*. 2010 Sep;16(9):e220-7.

Black S, Kushner I, Samols D. C-reactive protein. *J Biol Chem*. 2004 Nov 19;279(47):48487-90.

Henriquez-Camacho C, Losa J. Biomarkers for sepsis. *Biomed Res Int*. 2014;2014:547818.

Lelubre C, Anselin S, Zouaoui Boudjeltia K, Biston P, Piagnerelli M. Interpretation of C-reactive protein concentrations in critically ill patients. *Biomed Res Int*. 2013;2013:124021.

7

Suttie JW. Vitamin K. In: Machlin L, ed. *Handbook of Vitamins*. New York(NY): Marcel Dekker; 1984:147.

Van Winckel M, De Bruyne R, Van De Velde S, Van Biervliet S. Vitamin K, an update for the paediatrician. *Eur J Pediatr*. 2009 Feb;168(2):127-34.

Shearer MJ. Vitamin K deficiency bleeding (VKDB) in early infancy. *Blood Rev*. 2009 Mar;23(2):49-59.

Van Hasselt PM, de Koning TJ, Kvist N, de Vries E, Lundin CR, Berger R, Kimpen JL, Houwen RH, Jorgensen MH, Verkade HJ; Netherlands Study Group for Biliary Atresia Registry. Prevention of vitamin K deficiency bleeding in breastfed infants: lessons from the Dutch and Danish biliary atresia registries. *Pediatrics*. 2008 Apr;121(4):e857-63.

Booth SL, Al Rajabi A. Determinants of vitamin K status in humans. *Vitam Horm*. 2008;78:1-22.

Krasinski SD, Russell RM, Furie BC, Kriger SF, Jacques PF, Furie B. The prevalence of vitamin K deficiency in chronic gastrointestinal disorders. *Am J Clin Nutr*. 1985 Mar;41(3):639-43.

Shearer MJ, Fux, Booth SL. Vitamin K nutrition, metabolism, and requirement: current concept and future research. *Adv Nutr*. 2012 Mar;3(2):182-95.

Liebman HA, Furie BC, Tong MJ, Blanchard RA, Lo KJ, Lee SD, Coleman MS, Furie B. Des-gamma-carboxy (abnormal) prothrombin as a serum marker of primary hepatocellular carcinoma. *N Engl J Med*. 1984 May 31;310(22):1427-31.

8

Layton JB, Li D, Meier CR, Sharpless JL, Stürmer T, Jick SS, Brookhart MA. Testosterone lab testing and initiation in the United Kingdom and the United States, 2000 to 2011. *J Clin Endocrinol Metab*. 2014 Mar;99(3):835-42.

Bhasin D, Cunnigham GF, Hayes FJ, Matsumoto AM, Snyder PJ, Swerdloff RS, Montori VM; Task Force, Endocrine Society. Testosterone therapy in adult men with androgen deficiency syndromes: an Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab*. 2010 Jun;95(6):2536-59.

Liverman CT, Blaze DG, eds. *Testosterone and aging: clinical research directions*. Washington(DC): The National Academies Press; 2004.

9

Thygesen K, Alpert JS, White HD; Joint ESC/ACC/AHA/WHF Task Force for the Redefinition of Myocardial Infarction, Jaffe AS, Apple FS, Galvani M, Katus HA, Newby LK, Ravkilde J, Chaitman B, Clemmensen PM, Dellborg M, Hod H, Porela P, Underwood R, Bax JJ, Beller GA, Bonow R, Van der Wall EE, Bassand JP, Wijns W, Ferguson TB, Steg PG, Uretsky BF, Williams DO, Armstrong PW, Antman EM, Fox KA, Hamm CW, Ohman EM, Simoons ML, Poole-Wilson PA, Gurfinkel EP, Lopez-Sendon JL, Pais P, Mendis S, Zhu JR, Wallentin LC, Fernández-Avilés F, Fox KM, Parkhomenko AN, Priori SG, Tendera M, Voipio-Pulkki LM, Vahanian A, Camm AJ, De Caterina R, Dean V, Dickstein K, Filippatos G, Funck-Brentano C, Hellems I, Kristensen SD, McGregor K, Sechtem U, Silber S, Tendera M, Widimsky P, Zamorano JL, Morais J, Brener S, Harrington R, Morrow D, Lim M, Martinez-Rios MA, Steinhubl S, Levine GN, Gibler WB, Goff D, Tubaro M, Dudek D, Al-Attar N. Universal definition of myocardial infarction. *Circulation*. 2007 Nov 27;116(22):2634-53.

Eggers KM, Oldgren J, Nordenskjöld A, Lindahl B. Diagnostic value of serial measurement of cardiac markers in patients with chest pain: limited value of adding myoglobin to troponin I for exclusion of myocardial infarction. *Am Heart J*. 2004 Oct;148(4):574-81.

Macrae AR, Kavsak PA, Lustig V, Bhargava R, Vandersluis R, Palomaki GE, Yerna MJ, Jaffe AS. Assessing the requirement for the 6-hour interval between specimens in the American Heart Association Classification of Myocardial Infarction in Epidemiology and Clinical Research Studies. *Clin Chem*. 2006 May;52(5):812-8.

Kavsak PA, Macrae AR, Newman AM, Lustig V, Palomaki GE, Ko DT, Tu JV, Jaffe AS. Effects of contemporary troponin assay sensitivity on the utility of the early markers myoglobin and CKMB isoforms in evaluating patients with possible acute myocardial infarction. *Clin Chem Acta*. 2007 May 1;380(1-2):213-6.

Saenger AK, Jaffe AS. Requiem for a heavyweight: the demise of the creatine kinase-MB. *Circulation*. 2008 Nov 18;118(21):2200-6.

Reichlin T, Hochholzer W, Bassetti S, Steuer S, Stelzig C, Hartwiger S, Biedert S, Schaub N, Buerge C, Potocki M, Noveanu M, Breidthardt T, Twerenbold R, Winkler K, Bingisser R, Mueller C. Early diagnosis of myocardial infarction with sensitive cardiac troponin assays. *N Engl J Med*. 2009 Aug 27;361(9):858-67.

10

Garber JR, Cobin RH, Gharib H, Hennessey JV, Klein I, Mechanick JI, Pessah-Pollack R, Singer PA, Woeber KA; American Association of Clinical Endocrinologists and American Thyroid Association Taskforce on Hypothyroidism in Adults. ATA/AACE guidelines for hypothyroidism in adults. *Endocr Pract*. 2012 Nov-Dec;18(6):988-1028.

Dufour DR. Laboratory tests of thyroid function: uses and limitations. *Endocrinol Metab Clin North Am*. 2007 Sep;36(3):579-94, v.

U.S. Preventative Services Task Force. Screening for thyroid disease: recommendation statement. *Ann Intern Med*. 2004 Jan 20;140(2):125-7.

11

Bichakjian CK, Halpern AC, Johnson TM, Foote Hood A, Grichnik JM, Swetter SM, Tsao H, Barbosa VH, Chuang TY, Duvic M, Ho VC, Sober AJ, Beutner KR, Bhushan R, Smith Begolka W; American Academy of Dermatology. Guidelines of care for the management of primary cutaneous melanoma. *American Academy of Dermatology. J Am Acad Dermatol*. 2011 Nov;65(5):1032-47.

American Joint Committee on Cancer. AJCC cancer staging manual. 7th ed. New York: Springer; 2010.

National Comprehensive Cancer Network. National Comprehensive Cancer Network clinical practice guidelines in oncology (NCCN Guidelines®): melanoma. (Version 3.2015).

12

Mark McConnell, John R. Downes, Chester B. Good. Decrease the incentives to order lipid panels. *JAMA Intern Med*. 2014; 174(3):473. doi:10.1001/jamainternmed.2013.12872.

Stone NJ, Robinson JG, Lichtenstein AH, Goff DC, et al. Treatment of blood cholesterol to reduce atherosclerotic cardiovascular disease risk in adults: synopsis of the 2013 American College of Cardiology/American Heart Association Cholesterol Guideline. *Ann Intern Med*. 2014; 160: 339-343.

Stone NJ, Robinson JG, Lichtenstein AH, BaireyMerz CN, et al. 2013 ACA/AHA guideline on the treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Accessed September 11, 2014.

Sulkes D, Brown BG, Krauss RM, Segrest JP, et al. The editor's roundtable: expanded versus standard lipid panels in assessing and managing cardiovascular risk. *The American Journal of Cardiology*, 15 March 2008; 101(6): 828-842.

Virani SS, Woodard LD, Wang D, Chitwood SS, et al. Correlates of repeat lipid testing in patients with coronary heart disease. *JAMA Intern Med*. 2013; 12 Aug;173(15):1439-44.

13

Basnayake C, Ratnam D. Blood test for acute pancreatitis. *Aust Prescr*. Aug 2015;38:128-30.

Lankisch PG, Burchard-Reckert S, Lehnick D. Underestimation of acute pancreatitis: patients with only a small increase in amylase/lipase levels can also have or develop severe acute pancreatitis. *Gut*. Apr 1999;44(4):542-4.

Lippi, G, Valentino, M, Cervellin G. Laboratory diagnosis of acute pancreatitis: in search of the Holy Grail. *Crit Rev Clin Lab Sci*. Jan – Feb 2012; 49(1)18-21.

Shafqet MA, Brown TV, Sharma R. Normal lipase drug-induced pancreatitis: a novel finding. *Am J Emerg Med*. Mar 2015; 33(3):476.e5-6.

Smith RC, Southwell-Keely J, Cheshire D. Should serum pancreatic lipase replace serum amylase as a biomarker of acute pancreatitis? *ANZ J Surg*. Jun 2005;75(6):399-404.

Yadav D, Agarwal N, Pitchumoni CS. A critical evaluation of laboratory tests in acute pancreatitis. *Am J Gastroenterol*. Jun 2002;97(6):1309-18.

Viel JF, Foucault P, Bureau F, Albert A, Drosowsky MA. Combined diagnostic value of biochemical markers in acute pancreatitis. *ClinChimActa*. 1990;189(2):191-198.

14

Babak Pourakbari, Mona Ghazi, Shima Mahmoudi, Setareh Mamishi, Hossein Azhdarkosh, Mehri Najafi, Bahram Kazemi, Ali Salavati, and Akbar Mirsalehian. Diagnosis of *Helicobacter pylori* infection by invasive and noninvasive tests. *Braz J Microbiol*. 2013; 44(3): 795–798. Published online 2013 Nov 15.

Elvira Garza-González, Guillermo Ignacio Perez-Perez, Héctor Jesús Maldonado-Garza, and Francisco Javier Bosques-Padilla. A review of *Helicobacter pylori* diagnosis, treatment, and methods to detect eradication. *World J Gastroenterol*. 2014 Feb 14; 20(6): 1438–1449. Published online 2014 Feb 14. doi: 10.3748/wjg.v20.i6.1438

Theel ES, Johnson RD, Plumhoff E, Hanson CA: Use of the Optum Labs Data Warehouse to assess test ordering patterns for diagnosis of *Helicobacter pylori* infection in the United States. *J Clin Microbiol* 2015 Apr;53(4):1358-1360

Wang YK, Kuo FC, Liu CJ, Wu MC, Shih HY, Wang SS, Wu JY, Kuo CH, Huang YK, Wu DC. Diagnosis of *Helicobacter pylori* infection: Current options and developments. *World J Gastroenterol*. 2015 Oct 28;21(40):11221-35. doi: 10.3748/wjg.v21.i40.11221.

Tamadon MR, Saberi Far M, Soleimani A, Ghorbani R, Semnani V, Malek F, Malek M. Evaluation of noninvasive tests for diagnosis of *Helicobacter pylori* infection in hemodialysis patients. *J Nephropathol*. 2013 Oct;2(4):249-53. Epub 2013 Sep 1.

Talley NJ, Ford AC. Functional Dyspepsia. *The New England Journal of Medicine*. 2015;373:1853-63. Published online 2015 November 5.

15

Coleman JF, Theil KS, Tubbs RR, et al. Diagnostic yield of bone marrow and peripheral blood FISH panel testing in clinically suspected myelodysplastic syndromes and/or acute myeloid leukemia: a prospective analysis of 433 cases. *American Journal of Clinical Pathology* 2011;135:915-920.

Jiang H, Xue Y, Wang Q, et al. The utility of fluorescence in situ hybridization analysis in diagnosing myelodysplastic syndromes is limited to cases with karyotype failure. *Leukemia Research* 2012;36:448-452.

Pitchford CW, Hettinga AC, Reichard KK. Fluorescence in situ hybridization testing for -5/5q, -7/7q, +8, and del(20q) in primary myelodysplastic syndrome correlates with conventional cytogenetics in the setting of an adequate study. *American Journal of Clinical Pathology* 2010;133:260-264.

Seegmiller AC, Wasserman A, Kim AS, et al. Limited utility of fluorescence in situ hybridization for common abnormalities of myelodysplastic syndrome at first presentation and follow-up of myeloid neoplasms. *Leukemia & Lymphoma* 2014;55:601-605.

16

- Prieto VG, Argenyi ZB, Barnhill RL, Duray PH, Elenitsas R, From L, Guitart J, Horenstein MG, Ming ME, Piepkorn MW, Rabkin MS, Reed JA, Selim MA, Trotter MJ, Johnson MM, Shea CR. Are en face frozen sections accurate for diagnosing margin status in melanocytic lesions? *Am J Clin Pathol* [Internet]. 2003 Aug [cited 2017 Jul 14]; 120:203-208
- Taxy JB. Frozen section and the surgical pathologist: a point of view. *Arch Pathol Lab Med* [Internet]. 2009 July [cited 2017 Jul 14]; 133: 1135-1138
- Roy S, Parwani AV, Dhir R, Yousem SA, Kelly SM, Pantanowitz L. Frozen section diagnosis: is there discordance between what pathologists say and what surgeons hear? *Am J Clin Pathol* [Internet]. 2013 Sept [cited 2017 July 14];140:363-369
- Ali R, Hanly AM, Naughton P, Castineira CF, Landers R, Cahill RA, Watson RG. Intraoperative frozen section assessment of sentinel lymph nodes in the operative management of women with symptomatic breast cancer. *World Journal of Surgical Oncology* [Internet]. 2008 June [cited 2017 July 14]; 6:69-74
- Huber GF, Dziegielewska P, Matthews TW, Warshawski SJ, Kmet LM, Faris P, Khalil M, Dort JC. Intraoperative frozen-section analysis for thyroid nodules: a step toward clarity or confusion? *Arch Otolaryngol Head Neck Surg* [Internet]. 2007 Sept [cited 2017 July 14];133(9):874-881

17

- Michigan Department of Health & Human Services. Interpretation of newborn hemoglobin screening results. [Internet]. Lansing (MI): Michigan Department of Health & Human Services. 2015. [cited 2017 July 14]. Available from: http://www.michigan.gov/documents/mdch/Interpretation_of_Newborn_Hemoglobin_Screening_Results_Sep2013_438936_7.pdf
- Centers for Disease Control and Prevention, Association of Public Health Laboratories. Hemoglobinopathies: Current practices for screening, confirmation and follow-up. [Internet]. Silver Spring (MD): Centers for Disease Control and Prevention, Association of Public Health Laboratories. 2015. [cited 2017 July 14]. Available from: https://www.cdc.gov/ncbddd/sicklecell/documents/nbs_hemoglobinopathy-testing_122015.pdf
- Lane PA. Newborn screening for hemoglobin disorders. [Internet]. 2001. [cited 2017 July 14]. Available from <https://sickle.bwh.harvard.edu/screening.html>
- Ryan K, Bain BJ, Worthington D, James J, Plews D, Mason A, Roper D, Rees DC, De la Salle B, Streetly A. Significant haemoglobinopathies: guidelines for screening and diagnosis. *British Journal of Haematology*, [Internet]. 2010 Jan. [cited 2017 July 14]; 149, 35–49

18

- Marlar, RA, Gusman, JN. Laboratory Testing Issues for Protein C, Protein S, and antithrombin. [Internet]. 2014. [cited 2017 July 31]. Available from <http://onlinelibrary.wiley.com/doi/10.1111/ijlh.12219/full>
- McPherson R, Pincus M. 2011. Henry's clinical diagnosis and management by lab methods (22nd edition). St. Louis, MO: Elsevier.
- Shen, Y., Tsai, J., Taiwo, E., Gavva, C., et al. Analysis of thrombophilia test ordering practices at an academic center. 2016. [cited 2017 July 31]. Available from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4866738/>

19

- Joelson DW, Fiebig EW, Wu AH. Diminished need for folate measurements among indigent populations in the post folic acid supplementation era. *Arch Pathol Lab Med*. 2007; 131(3):477-480.
- Ray, JG, Vermeulen MJ, Boss SC, Cole DE. Declining rate of folate insufficiency among adults following increased folic acid food fortification in Canada. *Can J Public Health*. 2002;3(4):249-253.
- Latif T, His ED, Rybicki LA, Adelstein DJ. Is there a role for folate determinations in current clinical practice in the USA? *Clin Lab Haematol*. 2004;26(6):379-383.
- Shojania AM, VonKuster K. Folate assays are no longer useful diagnostic tools in medical practice. *Blood*. 2005;106(11 pt1):12b.
- Shojania AM. Folate assays are no longer useful as screening tests for malabsorption syndrome. Now, iron and B12 deficiency are more common than folate deficiency in adults with untreated celiac disease. *Blood*. 2005;106(11 pt1): 12b.

20

- Demay RM, *The Art & Science of Cytopathology*. Chicago, IL: ASCP Press; 1996
- Felten MK, Knoll L, Schikowsky C, et al. Is it useful to combine sputum cytology and low-dose spiral computed tomography for early detection of lung cancer in formerly asbestos-exposed power industry workers? *J Occup Med Tox*. 2014; 9(14): 1-9.
- Katz RL, Zaidi TM, Fernandez RL, et al. Automated detection of genetic abnormalities combined with cytology in sputum is a sensitive predictor of lung cancer. *Mod Pathol*. 2008; 21(8): 950-960.
- Read C, Janes S, George J, Spiro S. Early lung cancer: Screening and detection. *Prim Care Respir J*. 2006; 15(6): 332-336.
- Xiang D, Zhang B, Doll D, Shen K, Kloecker G, Freter C. Lung cancer screening: From imaging to biomarker. *Biomarker Res*. 2013; 1(4): 1-9.
- Usman AM, Miller J, Peirson L, Fitzpatrick-Lewis D, Kenny M, Sherifali D, Raina P. Screening for lung cancer: a systematic review and meta-analysis. *Prev Med* [Internet] 2016 Aug. [Cited 2017 July 14]; 89:301-14

21

- KDOQI US Commentary on the 2012 KDIGO clinical practice guideline for the evaluation and management of CKD. *Am J Kidney Dis*. 2014;63:713-735.
- American Diabetes Association. 10. Microvascular Complications and Foot Care: Standards of Medical Care in Diabetes—2018. *Diabetes Care*. 2018;41(Suppl 1): S28-S37.
- Vassalotti JA, Centor R, Turner BJ, et al. A practical approach to detection and management of chronic kidney disease for the primary care clinician. *Am J Med*. 2015;129:153-162.
- Berns JS. Routine screening for CKD should be done in asymptomatic adults....selectively. *Clin J Am Soc Nephrol*. 2014;9:1988-1992.
- Matsushita K, et al. Clinical risk implications of the CKD Epidemiology Collaboration (CKD-EPI) equation compared with the Modification of Diet in Renal Disease (MDRD) Study equation for estimated GFR. *Am J Kidney Dis*. 2010;60(2):241-249.
- <https://www.ascp.org/content/docs/default-source/get-involved-pdfs/istp-ckd/ckd-practice-algorithm.pdf>

22

- Triulzi D, Gottschall J, Murphy E, et. al. A multicenter study of plasma use in the United States. *Transfusion* 2015;55:1313-1319.
- Shah N, Baker SA, Spain D, et. al. Real-time clinical decision support decreases inappropriate plasma transfusion. *Am J Clin Pathol* 2017;148(2):154-160.
- Alcorn K, Ramsey G, Souers R, Lehman CM. Appropriateness of plasma transfusion: a College of American Pathologists Q-probes study of guidelines, waste, and serious adverse events. *Arch Pathol Lab Med* 2017;141:396-401.
- Holland LL and Brooks JP. Toward rational fresh frozen plasma transfusion: the effect of plasma transfusion on coagulation test results. *Am J Clin Pathol* 2006;126:133-139.
- Roback JD, Caldwell S, Carson J, et. al. Evidence-based practice guidelines for plasma transfusion. *Transfusion* 2010;50:1227-1239.
- Fatalities Reported to FDA Following Blood Collection and Transfusion Annual Summary for FY2016. [accessed Mar 20, 2018]. Available from: <https://www.fda.gov/downloads/BiologicsBloodVaccines/SafetyAvailability/ReportsProblem/TransfusionDonationFatalities/UCM598243.pdf>
- Garcia DA and Crowther MA. Reversal of warfarin: case-based practice recommendations. *Circulation* 2012;125:2944-2967.
- Gorlin J, Kinney S, Fung MK, et al. Prothrombin complex concentrate for emergent reversal of warfarin: an international survey of hospital protocols. *Vox Sanguinis* 2017;112(6):595-597.

23

Binnicker M: Hot topic: Serologic testing for rubella (video presentation with transcript); 2008: <http://www.mayomedicallaboratories.com/articles/hottopics/2008-08-rubella.html> (accessed 06/21/2017).

Best JM, O'Shea S, Tipples G, Davies N, Al-Khusaiby SM, Krause A, Hesketh LM, Jin L, Enders G: Interpretation of rubella serology in pregnancy—pitfalls and problems. *BMJ* 2001; 325:147-8.

Dietz V, Rota J, Izurieta H, Carrasco P, Bellini W: The laboratory confirmation of suspected measles cases in settings of low measles transmission: conclusions from the experience in the Americas. *Bulletin of the World Health Organization* 2004; 82:852-7.

Woods CR: False-positive results for immunoglobulin M serologic results: explanations and examples. *J Ped Infect Dis Soc* 2013; 2(1):87-90.

24

Davis BH, Holden JT, Bene MC, et al. 2006 Bethesda international consensus recommendations on the flow cytometric immunophenotypic analysis of hematolymphoid neoplasia: medical indications. *Cytometry B Clin Cytom.* 2007;72:S5-S13.

Oberley MJ, Fitzgerald S, Yang, DT, et al. Value-based flow testing of chronic lymphoproliferative disorders. A quality improvement project to develop an algorithm to streamline testing and reduce costs. *Am J Clin Pathol.* Sept 2014;142:411-418.

Healey R, Naugler C, de Koning L, et al. A classification tree approach for improving the utilization of flow cytometry testing of blood specimens for B-cell non-Hodgkin lymphoproliferative disorders. *Leukemia and Lymphoma* 2015; 56(9): 2619-2624.

Andrews JM, Cruser DL, Myers JB, et al. Using peripheral smear review, age and absolute lymphocyte count as predictors of abnormal peripheral blood lymphocytosis diagnosed by flow cytometry. *Leukemia and Lymphoma* 2008; 49(9):1731-1737.

Lim HY and Hong FS. Maximising yield of peripheral blood flow cytometry for chronic lymphoproliferative disorders. *Int J Lab Hem* 2018; 1-5.

Paolo Strati P and Shanafelt TD. Monoclonal B-cell lymphocytosis and early-stage chronic lymphocytic leukemia: diagnosis, natural history, and risk stratification. *Blood.* 2015;126(4):454-462.

25

Aassink-de Jong E, de Lange DW van Oers JA, et al. Stop Antibiotics on guidance of Procalcitonin Study (SAPS): a randomized prospective multicenter investigator-initiated trial to analyse whether daily measurements of procalcitonin versus standard-of-care approach can safely shorten antibiotic duration in intensive care unit patients – calculated sample size: 1816 patients. *BMC Infectious Diseases.* 2013;13:178.

Rhee C. Using Procalcitonin to Guide Antibiotic Therapy. *Open Forum Infect Dis* 2017;4:ofw249.

Bouadma L, Luyt CE, Tubach F, et al. Use of Procalcitonin to Reduce Patients' Exposure to Antibiotics in Intensive Care Units (PRORATA Trial): a Multicentre Randomised Controlled Trial. *Lancet* 2010; 375:463-74.

About the ABIM Foundation

The mission of the ABIM Foundation is to advance medical professionalism to improve the health care system. We achieve this by collaborating with physicians and physician leaders, medical trainees, health care delivery systems, payers, policymakers, consumer organizations and patients to foster a shared understanding of professionalism and how they can adopt the tenets of professionalism in practice.



To learn more about the ABIM Foundation, visit www.abimfoundation.org.

About the American Society for Clinical Pathology

The American Society for Clinical Pathology (ASCP) is the world's largest professional membership organization for pathologists and laboratory professionals. Our mission is to provide excellence in education, certification and advocacy on behalf of patients, pathologists and laboratory professionals across the globe. With 100,000 members, the society's influence has guided the application and evolution of the pathology and laboratory medicine specialty since 1922.



STRONGERTOGETHER

For more information or questions, please visit www.ascp.org.

For more information or to see other lists of Five Things Physicians and Patients Should Question, visit www.choosingwisely.org.