Pathologist Review of Peripheral Blood Smears

Over the past few months, a number of orders for pathologist review of a peripheral blood smear have been submitted to the hematology laboratory at Saint Luke’s Hospital (SLH). Upon review, many of these peripheral smears have had normal morphology and/or normal hematological parameters based on the automated complete blood count (CBC) or CBC with white cell differential (CBC/DIFF) results.

At SLH, the CBC and CBC/DIFF are performed on the Sysmex XE-2100 automated hematology analyzer, which can determine 32 different hematological parameters. This analyzer also incorporates a method for flagging white blood cell (WBC), red blood cell (RBC) and platelet abnormalities. The flagged abnormalities will prompt a manual peripheral smear review and differential by a clinical laboratory scientist to verify the abnormality flagged as well as allow identification of additional morphological abnormalities. A study performed at SLH showed that the sensitivity of the Sysmex XE-2100 for generating flags for abnormalities other than a left shift is 92%.

The following Sysmex XE-2100 flags will generate a peripheral smear review by a clinical laboratory scientist:

WBC Abnormalities
- Abnormal lymphocytes/lymphoblasts
- Atypical lymphocytes
- Basophilia
- Blasts
- Eosinophilia
- Immature granulocytes
- Left shift
- Leukocytopenia
- Leukocytosis
- Lymphopenia
- Monocytosis
- Neutropenia
- Neutrophilia
- Nucleated red blood cell abnormal scatter
- WBC abnormal scatter

RBC Abnormalities
- Fragments (schistocytes)

Platelet Abnormalities
- Platelet abnormal scattergram
- Platelet clumps
- Thrombocytopenia
- Thrombocytosis

If specimens are flagged for review, the following RBC morphological abnormalities, if present, are reported by the clinical laboratory scientist: polychromasia, acanthocytes (spur cells), ovalocytes (elliptocytes), spherocytes, sickle cells (drepanocytes), target cells (codocytes), schistocytes, stomatocytes, rouleaux and basophilic stippling. RBC inclusions (Howell Jolly bodies), granulocyte abnormalities (toxic granulation, Dohle bodies, Pelger Huet, hypersegmented polymorphonuclear leukocytes) and giant platelets are also reported if present.

Slides with newly identified blasts, prolymphocytes, plasma cells or unusual WBC and RBC morphology are submitted by the clinical laboratory scientist to a pathologist for review. In addition, healthcare providers may request a pathologist review as a write-in order on the SLH requisition form if further morphological review beyond what is performed for flagged Sysmex results is deemed necessary. In these cases, the indication for the pathologist review should be clearly stated on the requisition form.

**What is the Difference between Carbon Dioxide and Bicarbonate?**

Arterial blood gas analysis includes three parameters related to the carbon dioxide content of blood: partial pressure of carbon dioxide ($p$CO$_2$), plasma bicarbonate concentration (HCO$_3^-$), and plasma total concentration carbon dioxide (ctCO$_2$).
Of the three, only blood pCO₂ is actually measured during blood gas analysis, the other two are calculated. Total concentration of carbon dioxide can also be measured in plasma or serum by chemical methods and is reported with all chemistry panels containing electrolytes.

Partial pressure of carbon dioxide (pCO₂) is a measure of the pressure exerted by that small portion (≈ 5%) of total carbon dioxide in blood that is dissolved in the aqueous phase of plasma and blood cell cytoplasm. The measurement is made using a CO₂ specific pH electrode. In health, pCO₂ of arterial blood is maintained within the range of 35-45 mm Hg; pCO₂ of venous blood has a slightly higher range of 41-51 mmHg.

Most carbon dioxide (90%) is transported in blood as plasma bicarbonate. This parameter is calculated from pCO₂ and pH. In health, arterial plasma bicarbonate is maintained between 21-28 mEq/L. Venous bicarbonate is slightly higher at 24-30 mEq/L.

Total carbon dioxide content is calculated during blood gas analysis as the sum of all forms of carbon dioxide. Dissolved CO₂ contributes approximately 1.2 mEq/L to the total CO₂ in the plasma of arterial blood, explaining why ctCO₂ is usually this much higher than plasma bicarbonate. The ctCO₂ reference range is 23-29 mEq/L in arterial blood.

Unlike bicarbonate, which cannot be measured, ctCO₂ can be measured chemically and this parameter is routinely included with electrolytes. Since electrolytes are ordered much more frequently than arterial blood gases, measured ctCO₂ is often the first indication of a disturbance in acid-base balance. For all practical purposes, ctCO₂ and bicarbonate are equivalent, but a difference of 2-3 mEq/L is usually observed. Two factors account for this difference. Electrolytes are usually measured on venous blood and blood gases on arterial blood so there is a 1-2 mEq/L discrepancy due to the arterial-venous difference. There is an additional potential difference of 1.5 mEq/L due to the inclusion of dissolved CO₂ and carbonic acid in measured ctCO₂. However, this difference presupposes that no dissolved carbon dioxide is lost to the atmosphere prior to analysis, but this is often not case because electrolyte samples are not handled anaerobically. Since ambient air contains less CO₂ than blood, there is a tendency for dissolved CO₂ to be lost from the sample if tubes are left uncapped. If this occurs, measured CO₂ can decrease at a rate of 6 mEq/h. In contrast, calculated bicarbonate is not associated with the same risk of pre-analytic variation because blood gas analyses are sampled anaerobically with minimal delay.

**Checking Coagulation Results after Transfusion of Plasma or Platelets**

The laboratory is frequently asked how long you should wait after a transfusion of plasma or platelets to check a prothrombin time (PT), partial thromboplastin time (PTT) or platelet count. The answer is that specimens should ideally be collected within 30 minutes after completion of a transfusion. Infusion of plasma replaces deficient coagulation factors and should immediately shorten the PT or PTT. Checking a platelet count within 30 minutes after completion of a transfusion is the best way to determine if a patient has developed platelet refractoriness.

**Scholarship Awarded for Excellence in Clinical Laboratory Sciences**

Saint Luke’s Program in Clinical Laboratory Science was awarded a $5000 scholarship from Washington G-2 Reports, a national news and information company specializing in legislative, regulatory, legal and business aspects of the healthcare industry. The scholarship is given annually to recognize individual students or programs that demonstrate a high level of knowledge, motivation and drive for educational excellence in clinical laboratory science. It is sponsored by McKesson, and is intended to enhance and develop future leaders and qualified professionals.

Scholarship recipients in the Class of 2009 include Maureen O’Dowd, who received $2500 and represented Saint Luke’s Hospital’s CLS Program at Washington G-2 Reports 26th Annual Lab Institute meeting in Arlington, Virginia. Danielle Cole and Jessica Conrath were awarded $1250 scholarships. Saint Luke’s CLS Program has educated over 500 laboratory science students during the past 75 years.