MINI REVIEW

Modern Biomedical Sciences and Hematology Instrumentation

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The hematology instrumentation during its initial phase of development mainly relied on the achievement in basic physics such as electronic and optical discoveries. The most famous example of this was when Mr. Wallace H. Coulter used aperture impedance in developing the first blood cell counter[1]. Following this initial use of physics, hematology instrumentation now mainly utilizes techniques of aperture impedance, light scatter, fluorescence[2] and radio frequency.

In the last decade, biomedical sciences were quickly developing and profoundly influencing medical practice, and the associated medical instrumentation. The progresses in genome studies, novel therapeutic methods, gene transfers, targeted monoclonal antibodies and small molecules have resulted in many new challenges to hematology and other medical instrumentation because they may significantly alter the traditional clinical behaviors and courses in some diseases. Consequently, more novel parameters may be needed in diagnosis, and for monitoring and guiding of clinical treatment. On the other hand, the progresses in biomedical sciences have also provided many opportunities in hematology instrumentation due to the availability of many new techniques such as cell separation, cell marker detection and molecular analysis. A comprehensive application of these successes in modern biomedical sciences enabled us to obtain purified or enriched single type cells, observe their biological characteristics, which were impossible or very difficult before. Based on the observation and comprehension on the different type of cells, we can further investigate their behaviors and appearance on an automated clinical hematology analyzer, and establish some valuable new parameters.

In this issue of Sysmex Journal International, we selected some research works including Hematopoietic Progenitor/Stem Cells (HPC/HSC), Apoptosis and Nucleated Red Blood Cells (NRBC). These studies have revealed how the modern biomedical sciences are adapted in the hematology instrumentation. The measurement of HPC with a routine hematology analyzer had been predicted before[3, 4]. In 1995, the innovative cell purification techniques for CD34 positive cells were first applied in the study[5]. The behavior of CD34 positive cells on an automated hematology analyzer, SE-9000, was observed with a comparison of flow cytometer method. This study is a good example how modern biomedical techniques can be used in the hematology instrumentation. This investigation revealed that the CD34 positive cells were located in a narrow area in one (Immature Information Channel, IMI) of the observing channels in the hematology analyzer. That area was used for counting the cells and establishing the HPC program on the instrument. The parameter was consequently used in the clinical studies in screening of peripheral blood HSC in patients who are undergoing chemotherapy or in the prediction of success of HSC harvesting and transplantation.

Molecular biology is one of the fast developing fields in modern biomedical sciences. The techniques in DNA sequencing, synthesizing, cloning and transferring have established bio-pharmaceutical industry and produced clinical useful protein drugs. The genome program has succeeded in collecting human gene information, and enabled science to step into so called “Post Genome Era”. Apoptosis studies investigate the mechanism of programmed cell death, related clinical disorders and treatment. Since it was noticed and first named in 1972, it has attracted a lot of attention and interest from fundamental and clinical investigators. In 1996, the Imaging-combined Flow Cytometer (IFC) that was able to count cell number and reveal cell image simultaneously was developed in Sysmex. Apoptosis was first picked up in the study because of its frontier position in the fundamental and clinical medical sciences. The molecular biology methods used in the study significantly helped the understanding on the behavior of the apoptotic cells in the IFC analysis. The study suggested that IFC could be a powerful tool in the apoptosis research and also potentially in the future clinical application[6]. Another paper in this issue of journal further discussed the principle and techniques in IFC designs, and some other potential clinical applications in observing red blood cells and platelet aggregation with IFC.

The investigations on peripheral blood NRBC started more than 100 years ago. The observation and importance of this clinical phenomenon in diagnosis and prognosis of different disorders has been broadly discussed since then. However, the time consuming manual counting methods with their built in imprecision, inaccuracy and limitation in the counting number have been used until a few years ago. In 1997, different NRBC counting methods including flow cytometer and automated hematology analyzer XE-2100, were studied for automated NRBC counting. The studies demonstrated the automated hematology analyzer is much more precise, accurate and efficient than other methods[7]. Sequentially, the NRBC staging, and quality control/calibration materials were investigated[8] and developed by using cell sorting and Fluorescent In Situ Hybridization (FISH). The studies further suggested the role of automated hematology analyzer in more complicated cell analysis and potential future application of the instruments in looking at the whole picture of hematopoiesis system, including real bone marrow analysis. Other consequent studies further investigated the clinical significances of NRBC and application of XE-2100 in the NRBC observation.

The main purpose to republish the four papers together in this issue of Sysmex Journal International is to emphasize that the modern biomedical scientific methods are powerful tools in hematology instrumentation even though they are still in the preliminary stage and have not found all the solutions yet. They can provide clearer pictures about the blood cell characteristics and their behaviors in a given instrument. They also can help in the development of new parameters that were unavailable or difficult to develop by merely engineering centralized researches. More important is it can discover the mechanisms of our instrumentation in the view of biology and medical science. The integration of biomedical research, engineering and clinical studies would definitely promote the creation of valuable new parameters, and emerging of newer generations of hematology analyzers. This will provide the medical community more precise, accurate and reproductive instruments to meet the requirements from the potential altered clinical courses, diagnosis and treatment, eventually this will benefit patients through the new clinical significant parameters, lowering the test time, cost and length of hospital stay/visit. In a word, biomedical sciences will play even more pivotal role and become an integral part in the hematology and other medical instrumentation.

References

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