Importance of Cytometry for Clinical Diagnostics and Therapy

Ulrich Sack^a Jozsef Bocsi^b Attila Tárnok^b

^aDepartment for Clinical Immunology and Transfusion Medicine, University of Leipzig,

^bPediatric Cardiology, Heart Center Leipzig, University of Leipzig, Germany

This issue of TRANSFUSION MEDICINE AND HEMOTHERAPY presents a small and by far not comprehensive overview of state of the art applications of cytometric analysis of clinical specimens in diagnosis and quality control being of special interest for transfusion specialists and hemotherapists. Focusing on applications in pediatrics, the seven papers of this overview address, among others, age-related normal values, neonatal infection, congenital heart disease and cord blood stem cells [1–7].

Flow cytometry is an analytical technology that allows quantifying cell parameters by measurement of optical characteristics. Analytical specificity is enhanced and improved by specific staining aided by fluorochrome-labeled specific molecules such as antibodies, enzyme substrates or dyes to measure cell physiology (e.g. membrane potential, intracellular pH or calcium). Analysis of cells by cytometric methods has been proved in the recent years as a highly standardizable and reliable method for biomedical research, process controlling in biotechnology, and quality assessment in transfusion medicine and organ transplantation and in immunological laboratory diagnostics [8].

Flow cytometry has several important features that make it extremely useful in quality control in hemotherapy and transfusion medicine, e.g. high-throughput (fast acquisition) and high-content measurement by determining polychromatic multiple parameters on the same cell (multiplexing [9], cytomics analysis [10]). Based on only minimal sample volume [5], extensive data are acquired that can be used to predict individualized disease courses (predictive medicine by cytomics). This concept indicates the hope that, by understanding cellular networks, cell systems can be identified that predict individual disease progression, outcome and response to therapy [1, 11, 12]. For example, in transplantation medicine cytometric analysis actually is used to explore reliable periph-

eral biomarkers of relevant immune events that allows for monitoring of the immunosuppressive status of allograft recipients to predict pharmacodynamic drug effects and to individually balance immunosuppression [1].

By establishing more and more sophisticated technical approaches, such as multicolor analysis, slide-based cytometry and high-resolution detection of rare cell populations and weakly expressed molecules, a permanently growing number of applications for cytometric analysis has been introduced into routine diagnostic work [1, 6, 8]. Multicolor or polychromatic cytometric assays are advantageous as they allow for continuous monitoring of various parameters even in small children. Slide-based cytometry and related techniques offer unique tools to perform detailed immunophenotyping, enabling diagnostic procedures in very small sample volumes being two orders lower than those presently used in diagnostic routine [5]. Acquired data could have predictive value for individual risk assessment [10, 12].

By yielding quantitative data on the phenotypes and functions of leukocytes and lymphocytes, cytometry is an increasingly important tool in hemotherapy and transfusion medicine [1, 9, 13]. Moreover, the concentrations of multiple soluble blood compounds can be determined cytometrically by multiplexed bead arrays [14]. Further indications of cytometry are the determination of physiologic and pathologic conditions (allograft recipients [1], infected neonates [3], children with protein losing enteropathy [2, 7]), umbilical cord stem cell quality [4] and immune status of children [6].

In pediatrics where only minute blood volumes are at disposal the above mentioned advantages of flow cytometric analysis multiply each other. So it is not by coincidence that the main focus of the actual issue of TRANSFUSION MEDICINE AND HEMOTHERAPY is dedicated to the application of cytometric methods in children [2–7], summarizing some of the most in-

teresting recent developments in the area of theoretical and applied clinical flow cytometry. Although these articles can reflect only a small part of cytometric methods, they give a general overview about diagnostically relevant applications. Fur-

ther protocols are under investigation, and permanent improvement will allow to further reduce sample size, reagents' consumption as well as sample processing and acquisition time in the near future.

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