

Preface to Special Issue “Diagnostics”

by Masamitsu Shikata, Ph. D.

*Diagnostics Management Department, Analytical & Measuring Instruments Division,
Shimadzu Corporation, Kyoto, Japan*

(Received February 21, 2024)

1. Introduction

Diagnostics is a word that means “diagnosis” or “method of diagnosing,” and is used here to refer to the presumption of disease (clinical diagnosis) and clinical tests performed in the medical field. Diseases are diagnosed from a comprehensive perspective, including observation of symptoms, medical interviews, and the results of various clinical examinations. Clinical tests are performed not only at the time of diagnosis, but also when they are conducted to differentiate the characteristics of individuals with the disease, to determine the effectiveness of treatment, to confirm the effectiveness of treatment, and to determine complete cure or remission. Clinical tests cover a wide range of tests, including physiological tests that directly measure the human body, such as electrocardiography and ultrasonography, and laboratory tests performed on biological samples such as blood, urine, feces, or other body fluids. Laboratory tests can also be separated into biochemical tests, immunoserological tests, blood tests, and microbiological tests. PCR testing, which is often used to test for the SARS-CoV-2 virus and is now familiar to many, is also a type of clinical test. Clinical tests are performed when a disease is suspected, but also to test newborns for inherited abnormalities in newborn screening and to confirm whether a therapeutic drug has reached a prescribed concentration in the body.

This special issue of Shimadzu Review presents testing technologies based on mass spectrometry and microbial cultivation, which are particular strengths of Shimadzu Group, as well as the latest research into technologies that simplify existing tests and will lead to the development of new test methods. This special issue not only focuses on clinical testing technology, but includes research and development with a broader influence on the field of medicine, such as safety testing technology used to identify pathogenic contamination of cultured cells in regenerative medicine, technology used to maintain general health, and technology used to develop therapeutic drugs.

2. Microbiological Testing

Microbiological testing is used to identify pathogens in sputum, feces, blood, and other biological samples collected from patients with a suspected infectious disease and the results of microbiological tests play a crucial role in selecting effective antimicrobial treatment. Some infecting pathogens can cause sudden progression and lead to serious conditions, and tests that can identify these pathogens as soon as possible are of vital importance. With the rising issue of bacterial resistance to antimicrobial agents (drug-resistant microbes), testing that verifies if an antimicrobial agent is effective against a given pathogen (antimicrobial susceptibility testing) is also of prime importance. This special issue will discuss test methods in this area that use mass spectrometry and culture techniques along with technological developments that lead to faster testing.

3. Newborn Screening

Diseases caused by inherited genetic abnormalities or the vertical transmission of pathogens from the mother to the child can manifest themselves as metabolic, immune, or developmental disorders. The symptoms of these diseases can sometimes be mitigated by ensuring children receive treatment soon after birth, and all newborns in Japan are tested for metabolic abnormalities with the aim of providing this treatment (newborn screening). This special issue presents technologies that use mass spectrometry to detect inherited metabolic diseases.

4. Therapeutic Drug Monitoring (TDM)

Excessive administration of therapeutic drugs may lead

to side effects. In addition, administered therapeutic drugs are gradually metabolized (degradation) and eliminated from the body, reducing their concentration over time. For this reason, the effective concentration of certain therapeutic drugs, such as immunosuppressants and anticancer drugs, is defined in the body, and tests are performed to measure the blood concentration of the drugs. Some people have metabolic abnormalities, which can cause serious side effects if the administered drug is not broken down and remains at a high concentration. This special issue describes reagent kits that have been developed for measuring the concentration of anticancer drugs in blood using mass spectrometry.

5. Test Method Research and Development

Shimadzu Group is constantly seeking to improve the accuracy and sensitivity of existing test methods, simplify how samples are prepared before testing, and develop new methods of testing. For example, while genetic testing is becoming increasingly popular, accurate results from genetic testing require the purification of nucleic acids from biological samples to a high level of purity. This is often achieved using complex purification methods that are both time-consuming and can result in variable degrees of purification depending on the experience of the worker. This special issue discusses technological developments that expedite and simplify the purification of nucleic acids.

Exosomes are extracellular vesicles naturally secreted by cells that have attracted recent interest for their potential role in cancer and other diseases. This special issue also introduces technological developments related to the quantitation of exosomes as well as the latest developments in luciferases and other elemental technologies that can potentially establish new clinical test methods.

6. Safety Testing in Regenerative Medicine

Regenerative medicine uses embryonic stem (ES) cells and induced pluripotent stem (iPS) cells to build tissue and develop medical products. The pathogenic contamination of these cultured cells and tissues poses a significant chal-

lenge to the therapeutic use of these products. Although different from clinical testing, testing to confirm that the tissues and cells used for treatment are free of pathogens is important from a safety perspective. This special issue introduces technological developments that facilitate the comprehensive detection of viruses and microorganisms in the field of regenerative medicine.

7. Research and Development for General Health and Drug Discovery

Improved understanding of the gut microbiota has a useful role to play in maintaining general health and preventing and treating disease, and a wide range of research is currently focused on this goal. However, the intestinal environment is difficult to recreate under normal culture conditions, and culturing the many different microbial species of the gut microbiota together is a significant challenge. Shimadzu is currently seeking to resolve this issue by developing systems able to co-culture gut microbes *in vitro*. Drug development uses large numbers of laboratory animals, but concerns about animal welfare are creating an urgent demand for alternative approaches and Shimadzu Group is developing *in vitro* systems that mimic the human body to meet this demand. As well as these technologies, this special issue also discusses technologies that assist the production of useful substances.

8. Conclusions

Early discovery of disease has a substantial impact on subsequent treatment, and technologies that enable rapid and accurate testing are essential for the early discovery of disease. Rapid and accurate test methods are an important part of disease diagnosis, but also have an important role to play in the maintenance of general health. Shimadzu Group is committed to using its expertise in mass spectrometry, gene analysis, and microbial culture technology to develop medical devices, *in vitro* diagnostic pharmaceuticals, and other products and technologies that help people to pursue healthy and active lives.