

# Innovation: An Eternal Theme in the Development of Pediatrics

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The health problems of children differ greatly from those of adults. A child's response to illness and stress varies with increasing age. Pediatrics is a discipline that examines all aspects of the well-being of fetuses, infants, children, and adolescents, including their physical, mental, and psychologic growth and development. The development of pediatrics relies on innovation. Innovation is defined as the combination of new ideas, including new concepts, science, technology, and theories, which advance the development of various disciplines of pediatrics. Innovation has a strong influence on pediatrics, especially in promoting the quality of life of children, preventing diseases, and protecting children from health threats. Indeed, innovation is a driving force of the development of pediatric studies, providing the latest knowledge, theories, and technologies in pediatrics.

## RETROSPECTION ON SCIENTIFIC INNOVATION IN THE PEDIATRIC FIELD

Studies and explorations of pediatrics are based on the development of modern medicine. At present, several revolutionary breakthroughs in modern medicine should be highly valued by pediatricians. So far, the treatment of diseases resulting from trauma and infections has achieved remarkable progress;<sup>[1]</sup> however, research on genetics and the interaction between genetic backgrounds and environmental risk factors have lagged behind, making it difficult to treat a variety of pediatric diseases, including cancer, cardiovascular diseases, neurologic diseases, and metabolic diseases. In 2005, the Human Genome Project was finally completed. It was a milestone for human beings to overcome the current life-threatening chronic diseases. It has been confirmed that most diseases are not only caused by genetic changes

but also related to the abnormal expression of genes.<sup>[2]</sup> The regulation of gene expression is very complex and has become a hot topic of exploration. In addition, protein regulation is important for physiologic and pathophysiologic processes. Proteomics, or the study of the structures and functions of proteins, is making significant progress, which is of vital importance to address the pathogenesis and even the treatment of diseases. In addition to the genetic codes for DNA, the modifications of histones and DNA form other types of genetic codes. These kinds of codes, or epigenetics, can be inherited. The process is constrained by a variety of environmental factors. Epigenetics is the study of the role of these factors in genetic inheritance, which can provide a detailed understanding of certain diseases. In addition, systematic biomedicine is developing rapidly on the basis of postgenomics. It focuses on the interaction of various factors of the genome and proteome using modern biotechnologies, analyzing the causes of human behaviors and the underlying causes of diseases. Systems biology will also greatly enhance the effectiveness of medical research.

Notably, new diagnostic technologies and treatment methods have been developed in the last decade. In terms of new diagnostic technology, metabolomics has played an important role in its development. Metabolomics is an important part of phylogenetic biology. It has been developed rapidly by Nicholson since 1999 and was applied to the areas of functional genomics, precision therapies,

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nutrition, and other scientific fields. It has been widely used in the early diagnosis of diseases, drug development, toxicity assessment, environmental assessment, physiology, and other fields. Moreover, the development of molecular imaging technology has contributed greatly to the recent development of stem cell transplantation for the treatment of diseases. Molecular imaging is the product of molecular biology and modern medical imaging and aims to explore the occurrence, development, and outcome of disease. It shows the lesions at the tissue, cell, and even subcellular levels through imaging *in vivo*.

Concerning the development of a new therapeutic approach, stem cell transplantation has been viewed as a key technology. Stem cells show positive effects and application prospects in the treatment of many neurological diseases, hematological diseases, autoimmune diseases, endocrine diseases, and cardiovascular diseases.<sup>[3]</sup> Among them, the transplantation of neural stem cells in animal experiments could contribute to the treatment of ischemic encephalopathy. This minimally invasive surgery is a milestone in the development of surgery in the 21<sup>st</sup> century. With the accumulation of clinicians' experience and the improvement of minimally invasive instruments and techniques, children with minimally invasive surgery could expect to have less trauma, quicker recovery, less intraoperative hemorrhage, and less hospitalization. Furthermore, the use of digital subtraction equipment has resulted in the application of interventional treatment techniques. Pediatric intervention therapy has been applied to diseases in almost all parts of the body, especially in solid tumors, congenital heart diseases, and cerebrovascular diseases.

Although a great progress has been made, the current development of pediatrics is facing new challenges and opportunities. Ensuring the quality of life of children is vitally important for the society as a whole. These new diagnostic and therapeutic techniques have broadened our vision of managing diseases in a more basic and effective way.

## CONSIDERATIONS FOR FUTURE DEVELOPMENT OF PEDIATRICS

With the rapid development of the theoretical and technical methods of genetics, the genetic factors in the pathogenesis of pediatric diseases are drawing more attention and becoming better understood. In addition, pediatricians will be more concerned about environmental factors, including physical, chemical, and biological factors. In addition, factors related to nutrition, endocrinology, and other aspects of the environment will gain more recognition in the pathogenesis of diseases. With the development of epigenetics, knowledge of the interaction between genetics and environmental factors will make crucial contributions to the pathogenesis of diseases. Furthermore, we should realize that the body of a child is a complex system. There is a regulatory network that completes numerous regulation processes among various systems. This regulatory network is playing a more important

role in the pathogenesis of diseases. Future investigations are expected to make breakthroughs in this area.

With continuous discoveries and integrations of biomarkers, the value of these biomarkers in diagnosis will be further revealed. In addition, with the development of interdisciplinary disciplines, including science, engineering, and medicine, new diagnostic devices will continue to emerge, which will make the diagnostic process more comprehensive and precise and provide more insights into the nature of human diseases.

With further studies in genetics, genomics, proteomics, metabolomics, and the wide application of "big data," more advanced and precise therapies will be explored and discovered. Moreover, with the development of diagnostics as well as screening technologies, diseases can be detected and treated earlier, which will significantly improve the prognosis of diseases, especially in hematologic diseases, tumors, and cardiovascular diseases.

With the development of immunology and child health care, further breakthroughs will be made in vaccines, and some pediatric infectious diseases will be more effectively prevented.

It has been well established that many childhood diseases are chronic. The technology of rehabilitation will be further improved due to the continuous improvement of rehabilitation methodologies and equipment, and the quality of life of children will be improved substantially in the future.

To make a breakthrough in these frontier areas, pediatricians should establish a sense of innovation and implement innovative strategies in the future.

Pediatricians and investigators should always be at having scientific questions from bedside to be tested. In addition, innovation in pediatrics sometimes includes the exploration of new untested methods and treatment modalities. Thus, it is necessary to encourage and help the pediatricians to actively undertake the project of innovation and realize its importance. A substantial tolerance for the failure in the early stage of innovation is needed. Moreover, pediatricians also need timely feedback on their innovation performance and the reward for long-term success. In this way, they would increase the intrinsic motivation to conduct more innovative activities in pediatrics.<sup>[4]</sup>

An important concern for hospitals or research institutions is how to mobilize creativity among pediatricians for the development of novel, socially valued medicines and/or treatments. An innovation-supporting organizational climate is important for pediatricians to recognize the importance of such kind of innovation. The organizational climate is deeply influenced by the top managers' leadership style.<sup>[5]</sup> Various forms of laboratory meetings, journal club, seminars, and forums would help investigators to exchange their ideas of innovation.

Several disciplines, including mechanics, chemistry, mathematics, bioinformatics, and data science, can play

important roles in the development of pediatrics. For instance, interdisciplinary-based “big data” analysis provides a practical guide to its navigation, enabling us to harness its power to make ground-breaking biological discoveries more effective, conduct translational medical research, and implement personalized genomic medicine.

Pediatricians, administrators, and policymakers need to establish channels to achieve interdisciplinary interactions. Researchers from different countries and different fields need to actively gather together and discuss fundamental concepts. It is necessary to find new ways of exchanging information on scientific issues in pediatrics.

An increasing number of countries are paying attention to the cultivation of innovative medical talents. The reforms of medical education have prompted fundamental innovations in medical colleges.<sup>[6,7]</sup> For pediatricians, it is necessary to construct an interdisciplinary educational system and allow professors to recruit students from different majors to encourage the exchange of diversified knowledge within research teams.

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