



Translational pediatrics: reflections for the 21st century and beyond

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Guido Fanconi [1892–1979] is probably one of the most famous pediatricians and can be easily considered the founder of Modern Pediatrics in many aspects. Professor Fanconi was not only a Swiss pediatrician but one of the most reliable and authentic personalities in the field of pediatrics spanning at least the last two centuries (1,2). Born in Poschiavo, a municipality in the Bernina Region of Switzerland, in an initially wealthy family but disgraced in poverty after the Spanish-American war, Fanconi grew up in a small community of his hometown in the Canton of Grisons. He fought to become a physician due to several challenges in his life but reached such a professional level to give his name to several conditions and diseases in pediatrics. Fanconi was a determined medical student who started his career as a pathologist and physiologist with excellent knowledge of pathology, physiology, and biochemistry, of which the last was probably crucial for his success in medicine. The polyglot Fanconi entered the Universitäts-Kinderspital Zürich (Children's University Hospital of Zurich, Switzerland) in 1911 and remained in this institution for almost 45 years. At the astonishing age of 37 years, he became the chairman and head of the Kinderspital despite some growing rumors that he was more interested in research and biochemistry than truly possessing outstanding clinical skills to manage the chair position at the Universitäts-Kinderspital Zürich. These rumors were proven blatantly false because the Kinderspital became one of the most prominent pediatric hospitals

worldwide under his direction.

Fanconi described a hereditary pan-myelopathy with hyperpigmentation and short stature, now known as Fanconi anemia (FA) (1). Currently, the diagnosis of FA is made when there is an increase of breakage at chromosome level and the detection of “radial forms” on cytogenetics of lymphocytes and/or one of the next genetic features (3). They include either a heterozygous variation in *RAD51* recognized to determine the FA with autosomal dominant inheritance, or a hemizygous variation in *FANCB* recognized to induce X-linked FA, or biallelic variants identified in one of the genes recognized to trigger FA with autosomal recessive inheritance (3). Later, cystic fibrosis (CF), a multisystem complex disease involving epithelia of the exocrine portion of the pancreatic gland, hepatobiliary system, intestinal, and respiratory tracts, was first depicted in a thesis under his direction. Currently, the diagnostic identification of CF is based on a proband affected with one or more distinctive phenotypic features associated with proof of an abnormality in the function of the “cystic fibrosis transmembrane conductance regulator” (CFTR). His interpretation directed to pathophysiologic links climaxed in his estimate that trisomy 21 syndrome (Down syndrome) is owing to a chromosomal aberration, notably about two decades before the extra-chromosome 21 was found. Fanconi's name is also associated with renal physiology. De Toni-Fanconi or De Toni-Fanconi-Debré-Lignac syndrome is a rare renal disorder. This syndrome's

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eponym includes at times also Robert Debré [1882–1978], a French pediatrician at Necker-Enfants Malades Hospital in Paris, and George Otto Emil Lignac [1891–1954], a Dutch pathologist-anatomist, who also contributed to the study of this renal syndrome. Renal tubule dysfunction causes excessive amounts of glucose, bicarbonate (HCO_3^-), potassium, uric acid, phosphates, and some amino acids (chemical compounds harboring $-\text{NH}_2$ and $-\text{COOH}$ groups) being expelled in the urine of affected individuals. He understood the value of valuable and indispensable vaccines, and he was an advocate of vaccinations in childhood as we profess today (4). In 1941 a huge outbreak of poliomyelitis arose in Switzerland. Fanconi examined its epidemiology. He discovered that the virus was not spread by droplet infection. He remarkably argued that the virus came out of a gastrointestinal pathway like typhoid fever paving the pathway to support the current standard vaccination programs. The methodological approach used in past vaccination programs is straightforward. However, it seems having differed from the current approach used for COVID-19. The emergency procedure to validate COVID-19 vaccines has raised some unavoidable concerns on the full process considering the rarity of severe infection in children and youth and the uncommon occurrence of pediatric multi-inflammatory syndrome due to SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) in pediatrics (5). Such vaccination in children and youth has exhibited a substantial risk of myocarditis (6,7).

Translational Pediatrics actualizes the teaching and vision of Professor Fanconi, who embodies the evolution from an almost exclusively clinical approach to the current Modern Pediatrics and Precision Medicine in Pediatrics (3). Fanconi spent hours in his laboratory and in his wards recognizing the importance of importing data from bench to bedside. This exchange of information does not need to be reduced to mere concepts of future medicine but needs to be deeply interlaced with the personalized medicine, as we consider it now (8). The journal “*Translational Pediatrics*” may be considered the natural evolution of Pediatrics in a Modern Pediatric Medicine. Pediatrics is a very rapidly evolving field and is quite different from Fanconi’s time with regard to the knowledge of the diseases. Modern Pediatrics relies on the safe shoulders of both Professor Fanconi and the shoulders of other giants of Pediatrics, such as Professor Giovanni De Toni [1895–1973], who has been considered one of the most famous Italian pediatricians working at the Institute G. Gaslini in Genoa, Italy, which is my Alma

Mater and one of the largest children’s hospital worldwide. The highly precision-oriented diagnostic and professional means are enlarging the range of conditions that can be detected at bedside. Perinatal and Pediatric Care occurred during the last 20 years are progressed intensively. This progress is remarkably astonishing and galvanizing. We have strengthened the notion that children are not “smaller adults”. In fact, perinatal and pediatric pathology have developed as an independent subspecialty in the institution of pathology with unique crossings with fetal medicine, obstetrics, neonatology, biochemistry, physiology, and pediatrics. The prospect of endurance of premature babies and newborns with low weight or very low weight has risen at an exponential level. Despite these efforts, the respiratory and gastrointestinal tasks and the immunologic systems stay indeed critical. An enhanced percentage of infection at this age has been discovered. Moreover, sepsis and cardiovascular function may often derail, and they are intimately related to jeopardize their fragile life. The neonatal diagnosis techniques may overlap with procedural algorithms of diagnosis used at an older age. Still, in any state, they endure a dense and dynamic process, which necessitates a precise medical history, a skillful external examination, suitable laboratory tests, as well as imaging examinations with or without pathological assessment of tissue or liquid biopsies. However, clinical diagnosis may frequently remain elusive even with these tactics and steps forward. It may represent a pretty “long journey” from the first discovery of symptom or sign to the established diagnosis. To the pediatrician, new techniques currently seem to shorten this ride rapidly. Among the most encouraging approaches, the “next-generation sequencing” (NGS) may play a significant role in clinics in this decade (9). NGS has increased its application in clinics, despite one of the most intriguing caveats may dwell in its analytical validity. Metabolomics is certainly almost lightfast growing, chiefly in pediatrics. The technique of “liquid chromatography-mass spectrometry” (LC-MS) harboring a nanoflow pre-concentration (nLC-MS) is remarkable. Currently, nLC-MS is more often applied in the biochemical and proteomic fields to probe minor quantities of both proteins and peptide specimens. In metabolomics, just newly, nLC-MS is turning out to be more accepted than other advanced technologies. This approach is closely aligned with the current emphasis on personalized healthcare in medicine and appropriate patient management and laboratory information systems (10). Over the last decade, a spectrum of robust tests supporting the pre-clinical identification of pathologies are being



Figure 1 Gummy Bears potentially containing edible cannabis.

recognized. In clouds and electronic files and archives, new biomarkers are being discovered for several pathological entities in pediatric sciences. The proper management of pediatric conditions may become challenging. Targeting DNA snippets or single nucleotide polymorphisms for treating certain pediatric diseases has been proposed (11). Pediatric trial networks offer pediatricians, investigators, and federal agencies with new information on how children may respond to drugs and medications and biorepositories are key (12). Off-patent drugs deficient data on safety, efficacy, and dosing in the pediatric population may be targeted in the nearest future. Their primary objective is to produce the data showing probable health benefits and findings required to deliver evidence-based statements for future recommendations in clinical practice.

Children and adolescents have also been subjected to challenges and numerous difficulties between family and war conflicts. In the last two centuries, perinatal and child mortality have decreased, and innumerable diseases have been tackled at several levels. Multiple protocols from the “International Society of Pediatric Oncology” and “Children’s Oncology Group” have shown outstanding success in dealing with pediatric cancer, and minimal and fetal surgery has become a harbor for several surgical conditions. However, advocating for pediatrics also means eliminating drugs, politics, weapons, and gender-disorientation policies. The opioid crisis in North America is overwhelming. Illicit drugs, such as fentanyl and compounds derivatives from it, are often manufactured in clandestine laboratories of foreign countries. They are then marketed illegally on the street or online on criminal, recreational drug markets destroying entire generations of individuals.

The opioid and fentanyl epidemic is a tragedy for

our children and teenagers. The opioid abuse epidemic may have originated from physicians’ over-prescribing these drugs in chronic pain and/or not proper storage by adults. In many intoxication cases, there has been a poor consideration of the related risks due to over-prescription in our healthcare. Although opioid analgesics are considered addictive, families may not properly assimilate and store this information, and the potential for abuse is just behind the corner. Opioid analgesics are legally only available by a doctor with the correct license to prescribe these drugs. Recently, the abuse of opioid drugs has increased due to the recent pandemic and lockdowns, with children left discovering hidden places at home. In fact, the illegal online sales on the black market are a means to receive these drugs, but a method known as “diversion” has reached unprecedented levels recently. In this setting, drugs prescribed legitimately are subsequently given or sold on to third-party consumers. About one in 20 of the adult population of the United States of America may suggest evidence of misuse of prescription opioids, with more than 33,000 fatalities ascribable to overindulge with licit and illicit opioids in 2015, and, tragically, the most recent data are just climbing (13). The reality is that the life of our children and adolescents is in danger due to the access to these products, with or without lockdowns or epidemic or pandemic restrictions. In addition to the correctly formulated drugs, there is the horrendous dawn of illicit drugs sold by unlicensed online pharmacies, which market drugs even without medical prescriptions. Such pills are commonly forgery, manufactured by underground workshops, tainted by added ingredients, and not only hazardous but also often lethal. In addition to this situation, some countries have devastatingly permitted the use of cannabis as a recreational drug. This event represents a deleterious and noxious issue for children and adolescents who may be exposed passively or actively to cannabis or marijuana smoke. Also, a harmful effect may be associated with the spread of edible cannabis products (14-16). Several such contaminations and accidental intoxications have been reported with apparently innocent-looking candies or gummy bears (*Figure 1*). In order to safely thwart the propagation of the terrible health and social outcomes linked to such use, we need to act united and fight condescended governments. It is a great task and big challenge for the future of medicine and pediatrics, in which pediatricians, researchers, and lay people must commit and trust. How dare government figures present themselves as child-friendly in TV or social media, picturing them



Figure 2 The ascension of a child conducted by an infant angel. Sculpture of Horatio Greenough (American, 1805–1852), 1833, located at the Museum of Fine Arts, Boston, MA, USA (Gift of Laurence Curtis, Boston, MA, USA).

illustrating the support of children, youth, and families while they in reality harm them using horrendous policies? Pediatricians must be aware of such political figures and raise concerns about the truth behind the curtain on social media.

Another challenge is the diffuse and uncontrolled weapon in our societies. Despite considering an action against the second amendment, it is important to properly and wisely regulate access to weapons with a yearly license following psychological tests and proper investigation of how these guns are stored at home. It is critical to set apart criticisms and rivalries among or inside the parties, but a neutral body needs to act properly. Pesticides and insecticides taint our food. Household exposure to insecticides and pesticides has been recently identified as an important factor related to the increasing rate of pediatric cancer (17,18). Prenatal exposure to pesticide is strongly connected with an enhanced risk of occurrence of neuroblastoma, one of childhood's most frequent extracranial solid tumors. There is an odds ratio (OR) of 1.6. Khan *et al.* emphasized the IARC/WHO conclusions evaluating the carcinogenicity of some chemical compounds, including diazinon, glyphosate, malathion, parathion, and tetrachlorvinphos (17). Moreover, prenatal exposure relates to childhood brain tumors (OR =1.32). An equivalent phenomenon occurs after birth exposure (OR

=1.22) and residential exposure to insecticides and pesticides (OR =1.31). On the other hand, parental occupational exposure is only marginally associated with childhood brain tumors (OR =1.17). Feulefack *et al.*'s results are also in link with the IARC/WHO monograph assessing the carcinogenicity of several chemical compounds (18). Finally, exposing children to inappropriate sexualized content should be considered wrong, and any state, province, or country should be held accountable for those establishments that transgress this clear boundary. This has nothing to do with transgender people. Homophobic behaviors need to be marginalized and corrected, but inappropriate sex education at pre-puberal level may jeopardize the healthy progress of growth in children and adolescents. We need stronger laws than the current rules to protect children. We need bills and actions for parents to authorize law enforcement officers to shield children younger than 12 years old from businesses, recreation facilities, and events with drag queens and exposure to pornographic or inappropriate material and we need to act now.

I like to conclude my editorial referring to the sculpture of Horatio Greenough [1805–1852] (*Figure 2*). Greenough was an American artist who was best famous for his two United States' administration commissions, *The Rescue* [1837–1850] and *George Washington* [1840] (19). Greenough sailed to Rome, Italy, to study art before graduating from Harvard University. He came back to Boston in May 1827 after improving from a strike of malaria. Greenough sculpted several statues. He developed a marvelous work illustrating a child with an angel in marble. A deep serenity enlivens the child and the angel. This feeling does not differ to the Hadrian's words imprinted in the monument (8). The world is full of insidious events and challenges for children, and pediatricians should have a role of guardian angels advocating for children's physical and mental health effectively and efficiently. The improvement of nutrition and rickets is an example of the work provided by several pediatric societies advocating for fortified milk and more control on social services. The results of these enormous efforts have been impressive consolidating the concept of pediatric health care in several countries (20–23). Digitalization and proper storage of the imaging in medicine are crucial. Both pediatric radiology and pediatric pathology digitalization are a reality now in several institutions worldwide (10,24–28). Advances in precision medicine-based diagnosis and therapeutic protocols with the enactment of new technologies and compounds will be the foundation for the future of pediatric health care,

personalized pediatric medicine, and quality assurance (internal and external) and controls in the 21st century and beyond.

In ending this editorial, we would like to emphasize that, despite challenges and tragedies, resting on the shoulders of Professor Fanconi and other luminaries, pediatrics is evolving in personalized medicine, and the journal *Translational Pediatrics* with its remarkable impact factor will be a platform for many of these bench side experiments that may be brought to bedside.

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References

1. Lobitz S, Velleuer E. Guido Fanconi (1892-1979): a jack of all trades. *Nat Rev Cancer* 2006;6:893-8.
2. Royer P. Guido Fanconi or the triumph of clinical investigation in pediatrics. *Arch Fr Pediatr* 1979;36:967-8.
3. Sergi C. *Pathology of Childhood and Adolescence*. 1st ed. Springer, 2020.
4. Sergi CM, Leung AKC. Vaccination: a question of social responsibility. *J Prev Med Hyg* 2021;62:E46-7.
5. Sergi CM. COVID-19 in childhood and phenotypes of pediatric inflammatory multisystem syndrome. In: Rezaei N. editor. *Translational Autoimmunity*. 1 ed.: Elsevier, 2022:91-100.
6. Truong DT, Dionne A, Muniz JC, et al. Clinically Suspected Myocarditis Temporally Related to COVID-19 Vaccination in Adolescents and Young Adults: Suspected Myocarditis After COVID-19 Vaccination. *Circulation* 2022;145:345-56.
7. Sergi CM. mRNA vaccination in children and youth: a cautionary note. *Arch Med Sci* 2022;18:1404-6.
8. Sergi CM. Pediatrics: An Evolving Concept for the 21st Century. *Diagnostics (Basel)* 2019;9:201.
9. Auld FM, Sergi CM, Leng R, et al. The Role of N6-Methyladenosine in the Promotion of Hepatoblastoma: A Critical Review. *Cells* 2022;11:1516.
10. Sergi CM. Implementing Epic Beaker Laboratory Information System for Diagnostics in Anatomic Pathology. *Risk Manag Healthc Policy* 2022;15:323-30.
11. Corfield A, Meyer P, Kassam S, et al. SNPs: At the origins of the databases of an innovative biotechnology tool. *Front Biosci (Schol Ed)* 2010;2:1-4.
12. Sergi CM. Biorepository - A key component of research studies. *Contemp Clin Trials* 2022;112:106655.
13. Skolnick P. The Opioid Epidemic: Crisis and Solutions. *Annu Rev Pharmacol Toxicol* 2018;58:143-59.

14. Cohen N, Galvis Blanco L, Davis A, et al. Pediatric cannabis intoxication trends in the pre and post-legalization era. *Clin Toxicol (Phila)* 2022;60:53-8.
15. Lin A, O'Connor M, Behnam R, et al. Edible marijuana products and potential risks for pediatric populations. *Curr Opin Pediatr* 2022;34:279-87.
16. Kaczor EE, Mathews B, LaBarge K, et al. Cannabis Product Ingestions in Pediatric Patients: Ranges of Exposure, Effects, and Outcomes. *J Med Toxicol* 2021;17:386-96.
17. Khan A, Feulefack J, Sergi CM. Pre-conceptional and prenatal exposure to pesticides and pediatric neuroblastoma. A meta-analysis of nine studies. *Environ Toxicol Pharmacol* 2022;90:103790.
18. Feulefack J, Khan A, Forastiere F, et al. Parental Pesticide Exposure and Childhood Brain Cancer: A Systematic Review and Meta-Analysis Confirming the IARC/WHO Monographs on Some Organophosphate Insecticides and Herbicides. *Children (Basel)* 2021;8:1096.
19. Britannica, The Editors of Encyclopaedia. "Horatio Greenough". *Encyclopedia Britannica*, 2 Sep. 2022. Available online: <https://www.britannica.com/biography/Horatio-Greenough>, accessed 21 October 2022.
20. Zhang M, Shen F, Petryk A, et al. "English Disease": Historical Notes on Rickets, the Bone-Lung Link and Child Neglect Issues. *Nutrients* 2016.
21. Baumgartner-Sigl S, Haberlandt E, Mumm S, et al. Pyridoxine-responsive seizures as the first symptom of infantile hypophosphatasia caused by two novel missense mutations (c.677T>C, p.M226T; c.1112C>T, p.T371I) of the tissue-nonspecific alkaline phosphatase gene. *Bone* 2007;40:1655-61.
22. Sergi C, Linderkamp O. Pathological case of the month: classic rickets in a setting of significant psychosocial deprivation. *Arch Pediatr Adolesc Med* 2001;155:967-8.
23. Sergi CM. The Role of Zinc in the T-Cell Metabolism in Infection Requires Further Investigation - An Opinion. *Front Immunol* 2022;13:865504.
24. Sergi CM. Digital Pathology: The Time Is Now to Bridge the Gap between Medicine and Technological Singularity. In: Cvetković D. editor. *Interactive Multimedia - Multimedia Production and Digital Storytelling*. London, United Kingdom: IntechOpen, 2019.
25. Sergi C, Mikuz G. External quality assurance as a revalidation method for pathologists in pediatric histopathology: Comparison of four international programs. *BMC Clin Pathol* 2008;8:11.
26. Sergi C, Davis DD. Incident Reporting. *StatPearls*. Treasure Island (FL) 2022.
27. Sergi C. Promptly reporting of critical laboratory values in pediatrics: A work in progress. *World J Clin Pediatr* 2018;7:105-10.
28. Sergi C. Customer Care in Pediatric Cardiac Transplant Pathology: Basic Concepts and Critical Analysis in the Setting of Precision Medicine. *Ann Clin Lab Sci* 2019;49:682-5.

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