

A glimpse at the future

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One should not try to guess what the future holds without considering the past. I state this only to justify my references to personal experiences in the Faculty of Medicine when intending to scrutinize the future that awaits the pathologists.

In the 1970s, the nonsense that the Brazilian scientific agencies should preferably support projects of applied sciences became a reality. The stupidity of unqualified ministries is not a contemporary issue. This fact upset me substantially, since I could not see any sense in classifying science in “pure” and “applied” terms. I think that the predictability of benefits offered by the fruits of science is crucially complex and, to say the least, doubtful; it is much better to classify science as either “good” or “bad”. The dominant silliness also detracted my line of research, which consisted of the investigation of pulmonary microcirculation permeability using rats as an experimental model. I could no longer get resources for my projects. As the traditional wisdom taught me to dance according to the music, I submitted a “Project on Atmospheric Pollution” to FAPESP (Research Support Foundation of the State of São Paulo), with the help of professors Lawther and Spector from the St. Bartholomew’s Medical School of London where I did my post doctorate. After all, I knew a bit about rat lungs and suspected that they should suffer from air pollution just like us and, thus, at least I would continue to investigate pulmonary pathology.

The vocation, or if you prefer, the interest, of pathologists relies on the understanding and

elucidation of the mechanisms of illnesses. Like so many other professionals, the pathologist is curious, and the satisfaction of curiosities makes life worth living. The biological mechanisms refined over millions of years (interacting positively or negatively with the environment), the triumph of life on this planet called Earth, and the decreed finitude of the beings, provide a rich and fascinating universe to be explored. This belief suggests to me that the future of the pathologist remains granted as ever: the essence of our task will remain the same; however, the environment and the research instruments are changing. But what a change! It is the fastest and the most fantastic of all time.

Substrate to investigate shall never lack. Knowledge grows exponentially and, likewise, the mystery that surrounds us. I imagine our understanding domain as a ball undergoing incredible growth from which surface we scrutinize the unknown. The larger its circumference the more of the unknown we may glimpse. The complexity in which we live is undoubtedly increasing; however, it is important to note that there is no loss, but solely complementation. There is no obsolescence of old knowledge. The pathologist’s future is guaranteed as an analyst and synthesizer of diseases and illnesses of humankind, but his/her tools will dramatically change.

Lost in the centuries, pioneers tried to unveil the mechanisms of the diseases. They studied the body and its organs with only dissecting instruments at their disposal. Microscopy took more than a millennium to widen their observation. This revolutionary invention,

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developed in the 17th century, permitted the study of tissues and cells. Giovanni Battista Morgagni (1682-1771) is honored as the father of Modern Pathology, and 150 years later, Rudolf Virchow (1821-1902) was celebrated as the founder of Cellular Pathology. The discoveries accelerated and only a few decades passed to unveil the invisible molecular universe, which does not have a certified paternity; however, the term Molecular Biology is credited to the American, Warren Weaver (1894-1978).

Pathology—with a capital P—started to incorporate new techniques for microscopic observation: electronic microscopy, histochemistry, cytochemistry, and immunohistochemistry. I had the privilege to know and work with the father of histochemistry, Lucien Lison (1908-1984), a Belgian genius who attained Brazilian citizenship and was Professor of the Faculty of Medicine of Ribeirão Preto (SP-Brazil). The molecular investigation invaded the laboratories of Pathology and became imperative for many diagnoses: the real-time quantitative polymerase chain reaction, DNA microarray, DNA sequencing, molecular tillering of pathogens, and many other procedures that multiplied and enlightened our understanding. Of course, some of them come into sudden and unpredictable obsolescence; after all, techniques are ephemeral. In the perspective of the diagnostic routine, they are complementary to the optic microscopy. The pathologists only need to select some tools from the molecular biological arsenal to include in their personal routine. However, they should be able to orient themselves in this “sea of modernity,” to be familiar with the available resources and to use them according to the need of the diagnosis clarification, even when performed in other laboratories. One has to be ever updated. Even if it is tiring on the one hand, it backs off the monotony on the other.

I was not born in the Digital Era. However, I have lived its revolution, which was the most radical and violent ever. Several reliable sources state that all the existing knowledge from the dawn of humanity until 2003 is quite insignificant when compared with the added information of the last 12 years. Read *The Creative Destruction of Medicine*, by Eric Topol¹; it is the only reference here and is sufficient for this editorial, in my judgment.

I started my studies when phone communication was a privilege and the researchers unveiled the mystery of Golgi's apparatus. But now, since the millennium, I

live in a world where cell phones with their applicative cover the Earth, and the scientists sequenced the six billion bases of the human genome. In my late twenties the future could be foreseen, but not now; at best it is a well-educated guess. Besides the continuity of the disease's elucidation and the avalanche of new techniques, I will risk vaticinations about autopsies and diagnostic microscopy grounded in experience.

In the Faculty of Medicine of Ribeirão Preto, where I worked for 15 years, I had good training in autopsies under the supervision of Professor Fritz Köberle (1910-1983), who was exceptional in this art of our profession. Assuming the position of Full Professor at the Faculty of Medicine of the University of São Paulo in 1977, my first mission was to modernize the Coroner's Service of the city of São Paulo (SVOC), which I ran for many years. Simultaneously, I created the Experimental Laboratory of Atmospheric Pollution, and started to investigate the comparative study of the toxicity of automotive exhaust gasses. The difficulties of performing respiratory function tests in rats compelled the laboratory team to program it on computers. It was then that I woke up to the radical changes that were occurring in the world: a new era shook humanity in never-before-seen speed and violence. In 1983, I proposed to the Faculty's Congregation the creation of a Discipline of Medical Informatics, which took years to be approved and set up; it was only in 1987 that we succeeded in starting the first course of the new subject.

Thus, having experience in autopsies, and some computer literacy, I predicted that radical changes would emerge on the horizon: the practice of autopsies would yield, gradually, to the new techniques of exploitation by the Digital Era tools. Autopsies had already decreased with the clinical diagnosis progress that had exponentially speeded up since the 1950s, concomitantly with the reducing autopsy examination requests. Although the autopsy contributed—and still contributes—substantially to the elucidation of the diseases, resistance to its practice has always existed due to religious, cultural, and even social antagonisms. Consent reluctance by the family is the rule. Several nations avoid autopsies as much as possible; Israel and several Asian nations are good examples. Certainly, the advent of non-invasive techniques of exploitation would contribute to dispense a significant part of the consecrated routine of corpse examinations honored by the last 200 years and would receive a warm welcome by the world.

I developed these ideas in some forgotten journal in the early 1990s, and, surprisingly, received severe criticism from the Council of the Department of Pathology of the Faculty of Medicine of Ribeirão Preto. They registered in the minutes that I was *persona non grata!*

Some years passed and image-computing machines started to be integrated into the corpse examinations. Since 2015, in the Faculty of Medicine of the University of São Paulo, a powerful nuclear magnetic resonance machine joined the effort of several research groups to study the corpses of the SVOC in a multidisciplinary project.

The pathologists are information integrators par excellence: they receive clinical, surgical, laboratory, and other important data to reach a diagnosis. Contributory data from radiologists (or better: imagingologists) do not surprise them. However, if the autopsy is completely replaced by a non-invasive examination, their training will suffer marked changes. I consider it improbable that imaging professionals shall take our place; therefore, it is important to think to the future and prepare the pathologists to see with digital eyes. It will be easier than it was to train them on the microscopes 200 years ago.

And now, I will deal with the primary activity of the pathologists: the biopsies examinations.

Digital technology overcame the imaging analysis. Just reflect on taking money out of the bank by the recognition of our fingerprints—it is a new world. Advanced applicatives exist for anatomopathological image analysis, and the specialized literature has been debating their limitations and advantages over the last few years.

As previously mentioned, the Digital Era brought a radical change over a very short period of time. Its adaptations are neither uniform nor easy. Communication and economic practices have both suffered rapid and deep changes; the procedures with which I was educated are unrecognized nowadays: letters, bank checks, and money are effacing.

Not so in Medicine: it is an art notoriously refractory to changes. At the beginning of the 1990s, telemedicine was an experimental practice; today it is quotidian in a great part of the globe and prevailing in some regions, such as Abu Dhabi. The rampart of traditional medical practice won't resist the impact of cell phones and their applicative. We have to get used to them. The great majority of patients still see doctors in their clinics, but are ever accompanied by Dr. Google. We have to accept it. Creative destruction, a concept created in economy by the Austrian, Joseph Schumpeter, as far back as 1942, is one of the characteristics of the digital revolution and Medicine, earlier or later, will follow its inexorable destiny. We have to be prepared for it. This is the theme of the book written by Eric Topol¹ mentioned above.

I think that colleagues engaged in the routine of Pathology may rest in peace since their art will survive the upcoming years. Medical practice will take a generation—or a little longer—for a transformation to take place by creative destruction, and the traditional and the ancient will live together for a while during its modern reconstruction. However, I consider it imprudent if those who are responsible for future pathologists ignore the fact that they will act in an environment where devices capable of analyzing pathological preparations will join the already known reading machines of biological signs, images, molecular pathology, and genomic disorders.

We need to guard against, and not repeat, the tragedy of the tailors who faced the advent of the sewing machine, a product of the Industrial Revolution that started in England in 1760. Thousands of people became jobless—mainly women—and the great advantages of the sewing machine, which benefitted humanity, were only understood after a lot of suffering.

REFERENCES

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