MAEDICA – a Journal of Clinical Medicine
2021; 16(3): 343-345
https://doi.org/10.26574/maedica.2021.16.3.343

MÆDICA - a Journal of Clinical Medicine
EDITORIAL POINT OF VIEW

What Means Fourth Industrial Revolution for Medicine

Mircea CINTEZA, MD, PhD[a, b]

[a]Department of Cardiology, Emergency University Hospital, Bucharest, Romania
[b]"Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania

As mentioned in a previous paper (1), we are leaving today in the Fourth Industrial Revolution. Making a very long story short, the first industrial revolution began through using steam machines, the second through using electricity and the third through using the first computers (1). The fourth revolution is the most complicated one, because it includes many scientific achievements which have a global impact on society. Here are only some examples: energy capture, storage, and transmission, biotechnology, genetic engineering, the internet, robotics, faster computers, 3D printing, artificial intelligence and many others.

The term "Fourth Industrial Revolution" was officially introduced in 2016 by Klaus Schwab, a German professor of engineering and economy, in one of his books (2). He is a renowned personality who founded the World Economic Forum in Davos, which tries to shape the world agendas of development. Other names given to the Fourth Industrial Revolution are **4 IR or Industry 4.0**.

This concept has huge consequences on our daily life, blurring the boundaries between the physical, biological and digital worlds. The job market may become increasingly segregated into "low-skill/low-pay" and "high-skill/high-pay" roles, which could escalate social tension. There has never been a time of greater promise or potential peril (Klaus Schwab).

In this short paper we only mention some examples of the presence of very high technologies in some medical specialties without calling attention to imagistics, which must be added every time, as it has long become a common and basic instrument in medicine.

In **cardiology** there are at least three domains where new top technologies are already used: stem cells, mechanical intracardiac assist devices and arrhythmia ablation. Stem cells are used in two directions: implant stem cells after myocardial necrosis to replace the loss of contractile myocytes and development of collateral circulation. Clinical relevance of implanting stem cells to recover contractile function after myocardial necrosis is still weak. There are probably less than 100 clinical studies and about 1 000 treated patients. The ejection fraction of the left ventricle increased by 1.5-10% and rare results show a greater increase. The effect on mortality is not yet significant. There are many papers dealing with technical aspects which may vary a lot. I cite here only three papers which make some synthesis of the current achievements (3-5).

After the occlusion of a main coronary artery, some patients develop efficient collateral coronary circulation and their prognosis is better than in cases in which such collaterals do not develop. It is still not clear why some patients develop vigorous coronary collaterals and others do not. There are many papers dealing with the involved mechanisms, where stem cells also have an important role (6-8).

After large myocardial infarction, patients may develop severe dilated ischemic cardiomyopathy and need either transplant (which is a limited option) or mechanical support. One of the most promising approaches is to implant a left ventricular assist device (LVAD) into the left ventricle.

Address for correspondence:
Mircea Cinteza, MD, PhD
Department of Cardiology, Emergency University Hospital, 169 Independentei Avenue, District 5, Bucharest, Romania
Email: mirceacinteza@gmail.com

Article received on the 28th of September 2021 and accepted for publication on the 29th of September 2021

Clinical studies reveal that prognosis is similar with that in heart transplant (9-11). The most interesting observation was that, after being unloaded by the mechanical device for several months, some patients (not all) recover the contractility of the native myocytes. The phenomenon seems to be profound, implying biochemical mechanisms (10).

Ablation of arrhythmias developed a lot, in a field where drugs are completely ineffective or have dangerous side effects. Atrial fibrillation (AF), ventricular arrhythmia and others are ablated by radiofrequency ablation or cryoablation after a detailed mapping of the respective mechanism. In order to understand the complexity of the technique, I cite here only the names of some mapping techniques used to date for planning AF ablation (12): **fractionation mapping, voltage mapping, ripple mapping, high dominant frequencies mapping, focal impulse and rotor mapping, non-invasive body surface mapping, high density mapping**. Going further to the ablation procedure, the techniques become more complex.

For **oncology** we may cite only the main titles of medical technique used and see the huge variety of technologies: **robotic surgery, stereotaxic surgery, chemoembolization, stereotactic body radiation therapy (SBRT), cerebral navigation, monoclonal antibody drug therap**. Monoclonal antibodies, which seem to be an univewrsal way of treating cancer, may act in very different ways: **flagging cancer cells, triggering cell-membrane destruction, blocking cell growth, preventing blood vessel growth, blocking immune system inhibitors, directly attacking cancer cells, delivering radiation treatment, radioimmunotherapy, delivering chemotherapy, binding cancer and immune cells**. Every of these techniques uses a high top technology in the field (13).

Many of the cited technologies use different fields of **genetic engineering**. The main way of this technique is to introduce new DNA in the genome of a species. The **first recombinant DNA molecule was made by Paul Berg, in 1972, from two viruses** and **the first genetically modified organism (GMO) was a bacterium generated by Boyer and Cohen in 1973. Genentech, the first industrial company in the field, began to produce human insulin into *E. coli* in 1978.** Medicine and agriculture ar the main domains using today genetic engineering. In medicine, the main fields include **stem cells research, cloning, production of vaccines using mRNA (see COVID-19), producing hormons and other, synthetic biology to introduce new material into an organism, curing genetic diseases**.

There are some diseases that are cured, or may be cured, by genetic engineering. Here are some examples: **cancer** – clinical trials in progress, **beta-thalassemia and sickle cell disease, hemophilia, blindness** (hereditary forms)**, cystic fibrosis, Duchenne's muscular dystrophy, Huntington's disease and even AIDS and COVID-19** (13). There are tens of other examples and this paper cannot be too extensive, but they can be easily found lopokig for new trechnolgies in every medical specialty.

However, another achievement in progress has to be mentioned separately: creating human organs grown in an animal – for instance, pig. Numerous attempts have been made and some achievements are already seen. Here I just mention a paper published by a team in California (14); using one of the many techniques, called **CRISPR-Cas9-mediated zygote genome editing**, and manipulating the pig embryo, they are in the condition of obtaining adult pigs with human organs inside.

Instead of conclusion, I just wonder how will a paper like this look in three or seven years? Or, in other words, during which industrial revolution? ❑

References

1. **Cinteza M.** Industry 4.0 and Medicine. *MAEDICA J Clin Med* 2021;16:161-162.
2. **Schwab K.** *The Fourth Industrial Revolution.* Crown Business, 2016, ISBN 978-1-5247-5886-8.
3. **Higuchi A, et al.** Stem cell therapies for myocardial infarction in clinical trials: bioengineering and biomaterial aspects. *Lab Invest* 2017;97:1167-1179.
4. **Madigan M, Atoui R.** Therapeutic Use of Stem Cells for Myocardial Infarction. *Bioengineering* (Basel) 2018;5:28.
5. **Guo, R et al.** Stem cell-derived cell sheet transplantation for heart tissue repair in myocardial infarction. *Stem Cell Res Ther* 2020;11:19.
6. **Patel B, et al.** Coronary Collateral Growth: Clinical Perspectives and Recent Insights. DOI: 10.5772/67164.
7. **Das S, et al.** A Unique Collateral Artery Development Program Promotes Neonatal Heart Regeneration 2019. *Cell* 2019;176:1128-1142.
8. **Jamaiyar A, et al.** Cardioprotection during ischemia by coronary collateral growth. *Am J Physiol Heart Circ Physiol* 2019;316:H1-H9.
9. **Mehra MR, Uriel N, Naka Y, et al for the MOMENTUM 3 Investigators.** A Fully Magnetically Levitated Left Ventricular Assist Device — Final Report. *N Engl J Med* 2019;380:1618-1627.
10. **Birks EJ, et al.** Outcome and Primary Endpoint Results From a Prospective Multi-center Study of Myocardial Recovery Using LVADs: Remission from Stage D Heart Failure (RESTAGE-HF). *J Heart Lung Transpl* 2018;37:S142.
11. **Castillero E, Ali ZA, Akashi H.** Structural and functional cardiac profile after prolonged duration of mechanical unloading: potential implications for myocardial recovery. *Am J Physiol Heart Circ Physiol* 2018;315:H1463-H1476.
12. **Nedios S, et al.** Advanced Mapping Systems To Guide Atrial Fibrillation Ablation: Electrical Information That Matters. *JAFIB* 2016;896-102.
13. **Mayo Clinic online** – Mayo Clinic Staff.
14. **Wu J, Platero-Luengo A, Sakurai M, et al.** Interspecies Chimerism with Mammalian Pluripotent Stem Cells. *Cell* 2017;168:473-486.