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# Nanotechnology and Internet-of- Nano-Things (IoNT) for predictive health: Opportunities and Challenges

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**Abstract**— The requirements of a predictive medical diagnosis become more and more important. This involves early detection of antigens. The classical immunoassays are selective and sensitive but require several successive steps thanks to enzymatic markers, what does not meet the growing demand for medical diagnostics. The development of nanotechnology has opened up new fields of applications such as that of materials science and technologies with the emergence of Nano sensors in the field of biosensors. Because of their size comparable to that of biomolecules (enzymes, antigens / antibodies), the Nano-sensors, thanks to their quasi-molecular behavior due to their size, make it possible to increase the detection threshold. The interconnection of nanosensors with the internet for health monitoring has given rise to the Internet-of- nano-Thinks (IoNT). This paper, present a view of nanotechnology and the internet of nanomaterials for more predictive health monitoring.

**Keywords**— nanotechnology, Nano sensors, biosensor, nanomaterials, Internet-of-Nano-Thinks (IoNT), health monitoring.

## 1. Introduction

The global emergence of science and engineering at the nanoscale was marked by the announcement of the National Nanotechnology Initiative (NNI) in January 2000[1]. The rise of nanoparticles, electronic devices, nanomaterials has been possible thanks to nanotechnology. Technological advances have allowed nanodevices, ie nanomaterials, to perform tasks such as detection, and health care monitoring by being connected to the internet via a communication system complemented by a transmission system. This technological breakthrough has created a new field, namely the Internet of Nanotechnologies (IoNT) [2] .This area includes a better understanding of living and thinking systems, revolutionary biotechnological processes, the synthesis of new drugs and their targeted administration, regenerative medicine, neuromorphic engineering and the development of a sustainable environment [1].. Research on nanobiosystems is a priority in many countries and its relevance in nanotechnology is expected to increase the future, which, combined with advances in nanotechnology, will revolutionize almost every area of our lives. Nanotechnology and IoNT already play an important role in many applications in different sectors, such as agriculture and food, environmental protection, electronics, energy and biomedicine, health and medicine [2]. According to [3] Nanotechnology is a multidisciplinary field that covers a wide range of devices derived from engineering, physics, chemistry and biology. It allows for advanced medical science and disease treatment in health care [3] presents the main technical aspects of nanotechnology and its clinical applications in medicine through

materials interacting with the body at subcellular scales.

According to [4] Nanotechnology opens up new perspectives for combating and preventing disease through atomic-scale customization of materials. This leads to the improvement of biology, biotechnology, medicine and healthcare. The authors show that the integration of nanomaterials into biology has led to the development of precise diagnostic and monitoring devices and health treatment.Although in [5] The authors discuss the performance of intelligent drug delivery systems and show the requirements for the development of new nanotechnology-based systems. highlights the impact of nanotechnology in medicine and dentistry by showing that nanomedicine offers more sophisticated diagnostic possibilities and produce more effective treatments and preventive properties. According to [6], nanomedicine can simply be defined as an application of nanotechnology to biology in medical applications. The more detailed definition indicates that nanomedicine is an interdisciplinary scientific discipline that encompasses medicine, physics, biology, chemistry, engineering and optics for the processes of diagnosis and treatment of diseases through nanotechnology [6] - [7]. Strengthening nanomedicine with IoNT will lead to revolutionary changes in disease prevention, diagnosis and treatment. Otherwise, detection and early diagnosis of the disease will ensure accurate treatment and therefore promise a cure. Thus, in this work, the main reflections aim the development of an interconnectable NanoLabo by capitalizing the advances of the nanotechnology, the nanomedicine and the Internet of the objects.

## 2. Methodology

We used Google Scholar and IEEE Xplore search engines. The key word combinations used to collect data from these engines are: "Nanotechnology in medicine and health", "Nanotechnology and the internet of nanomaterials", "Nanotechnology and the internet of nanomaterials and patient monitoring". One hundred and thirty-four (134) items were found between 1965 and 2019 within the limits of our research. We have classified these articles according to the criteria of our research. Thus, eighty-seven (87) items were excluded as shown in Table 1 and seveny-seven (47) items were the subject of our study.

Table 1. Item by year

| Year | Number of articles found per year | Number of articles excluded per year |
|---|---|---|
| **1965** | 7 | 6 |
| **1976** | 6 | 5 |
| **1998** | 5 | 4 |
| **1999** | 7 | 6 |
| **2001** | 10 | 7 |
| **2003** | 7 | 5 |
| **2004** | 8 | 6 |
| **2005** | 5 | 4 |
| **2006** | 6 | 5 |
| **2007** | 7 | 4 |
| **2008** | 10 | 6 |

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| Year | Number of articles found per year | Number of articles excluded per year |
|---|---|---|
| **2009** | 8 | 4 |
| **2010** | 9 | 3 |
| **2011** | 5 | 4 |
| **2012** | 8 | 4 |
| **2013** | 8 | 6 |
| **2014** | 4 | 3 |
| **2015** | 7 | 2 |
| **2016** | 3 | 2 |
| **2017** | 4 | 1 |
| **2018** | 0 | 0 |
| **2019** | 0 | 0 |
| **TOTAL** | 134 | 87 |

## 3. Result and discussions

### *3.1 Nanotechnology in medicine and research fields*

In the health care sector, there are many applications of nanotechnology. We have diagnostic imaging applications, pharmaceutical type applications. There are also mechanisms for medical implants and drug delivery devices [8]. Therefore, nanomedicine is the process of diagnosis, treatment and prevention of traumatic diseases and traumas through the use of nanoscale structured materials and simple nanodevices, which can be manufactured today. According to [9] in the applications of nanotechnology in medicine and health care, nanomaterials have been classified into three sections. They showed the importance of nanotechnology in drug and gene delivery, controlled release systems, molecular imaging and diagnostics, cardiac therapy, dental care, orthopedics and targeted cancer therapy . According to [10] the use of Nanosensors for blood sugar monitoring and shows that Nanotechnology has had an impact on taking blood glucose measurements for monitoring diabetes by increasing the surface of the sensors, improving the catalytic properties electrodes and providing sensors at the nanoscale. The most complex of machines is the human machine, ie the human body with living cells that they overflow with highly functional nanoscale. The human machine formed by the cells is composed of macromolecules, especially proteins. These are involved in almost all cell processes, such as information transfer, metabolism and substance transport. Nanotechnology offers new tools to observe the functioning of these machines at the level of individual molecules, even in the living cell[11] . Atomic force microscopes, may allow, measure the binding forces between triggering substances, such as hormones, and associated receptor proteins that act as switches in the cell membrane [11]. Biomolecules can be labeled with quantum dots. The intense light of a specific wavelength emitted by these nanocrystals makes it possible to precisely trace the path taken by the biomolecules in the cells. [12]. Most of the research in this area is related to taking information on the various processes in biochemistry and biophysics in healthy and sick cells. Further research is being conducted concurrently on many potential applications of nanotechnology in medicine[13] . Further research is underway to investigate new methods and tools for imaging using nanotechnology [14], detection[15] . There is also ongoing research on application applications in the field of tissue medical implants [11]

### *3.2 Nanomedicine*

Nanomedicine is the application of nanotechnology for early diagnosis, treatment, control and medical surveillance. Although nanomedicine seems to be new, the first bases of a medical application of nanotechnology go back about twenty years ago. The very first example of lipid vesicles was described around

1965 [4] [16]. The very first controlled release system based on the polymer dates back to 1976[17] and the first nanowire nanosensor dates back to 2001 [18] Several new studies are being made on nanoparticulate contrast agents for the early detection of atherosclerosis and cardiovascular pathology at the cellular and molecular levels, which could be next frontier between imaging and the rational administration of drugs to make easier the personalization of medicine[4] . The introduction of more efficient nanotechnology-based biomarkers for early diagnosis and surveillance will have a major impact on patient management, improving the quality of life of patients and reducing mortality, especially in cancer and noncommunicable diseases including diabetes and blood pressure, contrast enhancement by MRI.
In the long run the ideal of research in nanomedicine is to characterize the quantitative components at the molecular level known as nanomachines. Precise control and manipulation of the nanomachines inside the cells will identify the cellular mechanisms of living cells and develop state-of-the-art technologies for the early diagnosis and treatment of various diseases. The importance of this research lies in the development of a technology platform that will influence nanoscale imaging approaches to explore the molecular mechanisms in living cells [19][.Nanotechnology with molecular imaging will provide a versatile platform for the innovative design of nanosondes or nanosensor-like nanosensors that will have considerable potential to improve the sensitivity, specificity and signaling capabilities of various biomarkers in human diseases.[20] Nanoparticle probes will give imaging techniques increased signal sensitivity, improved spatial resolution, and the ability to relay information about biological systems at the molecular and cellular levels.

### *3.3 Synthesis: Challenge*

While the nanomachines require in vitro manipulation, the idea envisaged is to have an interconnectable NanoLabo, illustrated in FIG. 1 by capitalizing the advances of nanotechnology, nanomedicine and the Internet of Things. Which would allow to have a network of Nanosensors-Labo: Internet of NanocaptorLabo (IoNClT)

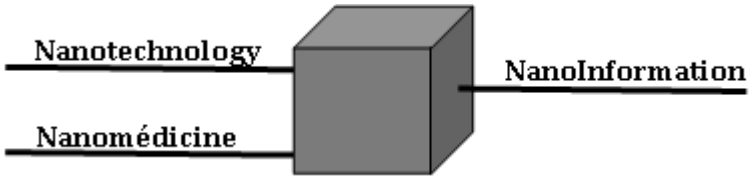


Fig. 1. NanosensorLabo interconnectable

## 4. Conclusion

This article presents the technological advances of nanotechnologies and their different applications in medicine, hence nanomedicine. The challenge here is to capitalize on advances in nanotechnologies and nano medicines in order to bring out the interest of nanosensors. The challenge for future research is the development of a nanosensor. even microscopic data to ensure the early prediction of any disease.

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