

## Impact of engineering on medicine: a literature review

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Received (12/04/21), Accepted (06/05/21)

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**Abstract:** This paper presents an analysis of the evolution of engineering and its current impact on health and medicine. The bibliographic documentation is analyzed and the most relevant aspects that highlight engineering and its contribution to new clinical developments are shown. The results show that medicine has an evolutionary need to adapt to new technological developments and that engineering plays a fundamental role in the advancement of medical, health, and scientific processes in general.

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**Keywords:** Engineering, technology, medical advances, health developments.

## Impacto de la ingeniería en la medicina: una revisión bibliográfica

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**Resumen:** En este trabajo se presenta un análisis de la evolución de la ingeniería, y su actual repercusión en la salud y la medicina. Se analiza la documentación bibliográfica y se muestran los aspectos más relevantes que destacan a la ingeniería y su aporte en los nuevos desarrollos clínicos. Los resultados muestran que la medicina tiene una necesidad evolutiva, que debe acoplarse a los nuevos desarrollos tecnológicos, y que la ingeniería juega un papel fundamental en el avance de los procesos médicos, de salud y científicos en general.

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**Palabras Clave:** Ingeniería, tecnología, avances médicos, desarrollos en la salud



## I. INTRODUCTION

The new medical challenges include the application of traditional medical knowledge and its linkage with new technological trends. The contribution of engineering in medical processes [1], [2] has meant greater efficiency in clinical diagnosis and turn the discovery of new ways to address the most complex health problems.

Engineering advances have made it possible to address different professional areas, contributing significantly to the solution of problems and the improvement of processes. New technologies are not only a solution tool for present situations but also for the prognosis of future situations, both to know their origins and to face their possible variants over time.

In the 20th century, medicine had an important advance in society, politics, and science [3] And here it should be mentioned the significant professional trajectory of the scientist Jacinto Convit [4], who developed the vaccine against leprosy and the dignification of the sick. It is also worth mentioning the development of insulin in 1922 [5], the first vaccine for whooping cough [6], there was also a high level of scientific development in several vaccines [7], the development of medical equipment [8], and a different medical vision that motivates engineering to actively participate in clinical solutions.

Engineering, on the other hand, experienced in the 20th century a high scientific growth, with the development of software and artificial intelligence techniques, opened a new panorama for engineering, as well as a new contribution for all professional branches. Engineering began to get involved in different professions, to provide innovative, optimal, and scientific-technological solutions.

This paper reviews the contributions of engineering in medicine, especially in times of pandemics, where the need for fast and efficient solutions grows spontaneously. Thus, a systematic review of the scientific results and technical contributions of engineering is carried out.

This work consists of four sections, the first one has described the premises of the research, the second one shows the theoretical aspects developed, then the methodological foundations are exposed and finally, the results and conclusions are described.

## II. THEORETICAL FUNDAMENTALS

Some of the most outstanding scientific advances, where engineering was used, are detailed below. The list of contributions could be extremely long, but only some of the most outstanding contributions that have an impact on the current world health situation have been considered. To this end, the microscope is evaluated as an indispensable piece of equipment in medicine that has gone through several eras, improving each time with technology. Then recent developments in times of pandemics, which favor improvements in health and the preservation of life, are evaluated.

### *A. Microscope history*

The microscope was invented in 1590 [9] and meant an important advance for medicine. Its creator was Zacharias Janssen who was a manufacturer by profession, that is, the first signs of engineering. Later on, other inventors perfected this equipment and managed to improve the quality of image detection.

The evolution of engineering also allowed the microscope to make significant progress, and in turn, its use in medicine became indispensable for the detection of important clinical situations. Today it is even possible to conceive the virtual microscope [9], [10], which allows the analysis of samples remotely without the need to depend on schedules. This equipment can analyze static or dynamic samples.

Engineering and its big data processing, image processing, information processing, calculation have been timely to contribute to the development of medical equipment that favors medical studies.

### *B. Artificial respirators*

Mechanical ventilators are a scientific development that has been evolving since 1543 [11]. It has had an important development throughout history and has been able to attend innumerable medical situations related to respiratory processes.

Today, with the COVID-19 pandemic, the need for mechanical ventilators has been extended throughout the planet. Engineering has played an important role in the design, development, and improvement of medical ventilatory equipment. Various pieces of equipment have been proposed as an alternative to clinical situations in intensive

care units [12].

Understanding the respiratory system is fundamental to the development of equipment that offers more efficient and optimal processes.

The respiratory system can be divided into two sections: conduction airway and gas exchange units [13].

#### *A. Airway conduction.*

Its main function is to condition and direct the air before it reaches the alveoli. It therefore warms and humidifies the air and filters out foreign particles.

There is an upper airway: nose, pharynx, and larynx; and a lower airway: trachea and bronchi.

The bronchial tree branches into bronchioles and terminal bronchioles (the smallest part of the airway before reaching the alveoli). This is called the conduction airway or dead space.

#### *B. Gas exchange units.*

The area of the lung that depends on the terminal bronchiole is called the acinus or pulmonary respiratory unit. It gives rise, and in this order, to: respiratory bronchioles, alveolar ducts, alveolar sacs and alveoli. It is in the alveoli, that gas exchange takes place.

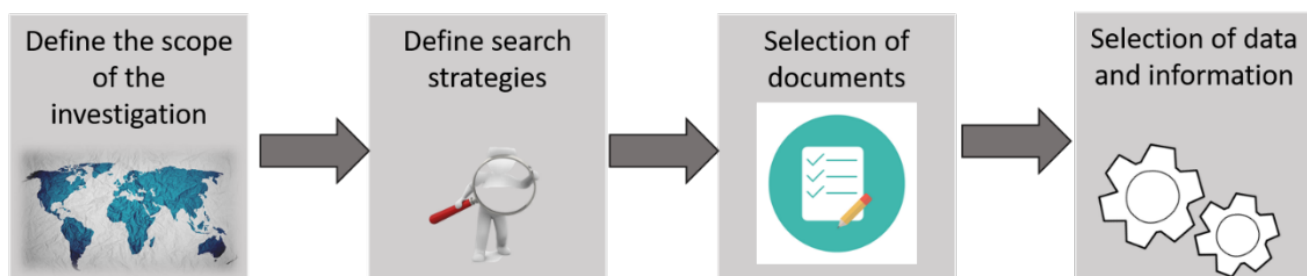
In the wall of the alveoli a phospholipid called surfactant or surfactant is produced whose function is to protect the alveoli from collapse during expiration.

#### *C. Blood supply.*

The lung is an organ with a double blood supply: on the one hand, it receives blood from the minor circuit through the pulmonary arteries (venous blood); and on the other hand, from the major circuit through the bronchial arteries (arterial blood).

### III. METHODOLOGY

In this work, a set of scientific papers was analyzed and the most relevant aspects of engineering and its participation in medical developments were taken into account. The review process followed the scheme shown in Figure 1.



**Fig. 1. Information selection process.**

#### *A. Exclusion criteria*

For the selection of the academic papers, those that did not correspond to engineering advances and that only dealt with medical aspects were excluded. In addition, all papers that did not make a significant contribution to this research were excluded.

#### *B. Inclusion criteria.*

For the inclusion of scientific material in this work, we considered those that contained relevant information on the subject, as well as those with recent dates. In addition, priority was given to papers published in leading

databases such as Scopus, with a high impact factor.

Engineering and its inventions have been overshadowed by other scientific branches, which could not have stood out in science without the support of inventors and engineers who supported the discoveries. At present, engineering stands out as a tool allied to many professional branches.

#### IV.RESULTS

Once the review process has been completed, the following results can be described:

1.Engineering is born as the result of inventions and creative processes to contribute to social needs and contribute to all sciences.

2.The development of engineering has allowed a technological advance in societies, not only in the development of computational equipment but also in the contribution in all professional branches, in the design of equipment and machines that provide solutions to an infinite number of problems. We can mention portable equipment for DNA detection, mechanical respirators, X-ray equipment, robotic mechanisms for laparoscopy, among many others that have improved medical care.

3.Medicine faces a global health problem that can only be overcome or attenuated with the support of engineering, taking into account medical equipment for the evaluation of samples, data processing, information selection, and all those mechanisms that help in-hospital clinical assistance.

4.The development of new technologies could be a path to health improvements in future societies.

#### V.CONCLUSIONS

At the end of this bibliographic review, the following conclusions can be drawn:

1.Medicine is a science that, in addition to caring for the health, is responsible for attending to the problems caused by diseases, thus it has the task of preserving and restoring health, and this is only possible with technological tools that contribute to the improvement of processes, the efficient detection of variables, the processing of data and information, and the management of medical situations.

2.Engineering must be at the service of all professions, to offer efficient, useful, practical, and optimal solutions that facilitate scientific work and provide improvements to people.

3.The alliance of engineering and medicine can mean an important technological advance for societies, which will result in better medical care, better detection of health problems, better follow-up of problems, more efficient methods, and, consequently, more options for improvement and better quality of life for people.

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