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Review Article

Impact of the "Omics Sciences" in Medicine: New Era for Integrative Medicine

Abstract

Background and objective: This work collects and analyses information about the evolution of medical practice during the last centuries. The main aim is to summarise new insights on "omics sciences" and their impact in medicine.

Methods: Use of appropriate keywords, use of different engines of research information and the subsequent bibliometric analysis of the information.

Results: The impact of the "omics sciences" in the early diagnosis of diseases is highly significant. Consequently, the implementation of "omics sciences" in medical practises contribute to the improvement of the monitoring and treatment of several diseases (particularly those based on molecular disorders).

Conclusions: Advances in the techniques of biotechnology, analytical chemistry, biochemistry, and molecular biology are the source of the emergence and rapid evolution of a new omics era. This omic era has allowed the introduction and development of a medicine much more optimised and personalised, which is considered by many professionals as the medicine of the 21st century. This work is timely due to the high international interest for personalised medicine, healthcare and quick medical diagnosis.

Introduction

"Medicine" is a generic term used to refer to all those activities and techniques that are intended to maintain or restore the health of human beings (http://www.etymonline.com/index.php?term=medicine). However, there are various views and theories (also called paradigms) in the implementation of the medicine that have arisen and evolved throughout the history. These different approaches of practising medicine have advanced simultaneously to the improvement of the knowledge about the human being. Consequently, medicine is being strongly influenced by traditions, culture and scientific and technological advances [1].

These paradigms are confronted due to the existence of significant conceptual and/or methodological differences. The search for a common purpose on the part of all of them, makes difficult to establish the limits between them [2]. Besides, the use of various technical terms is confusing. For this reason, it is necessary to describe some relevant concepts, as well as to distinguish the main types of existing medical paradigms. This situation becomes even more chaotic as soon as new technological approaches are implemented on medicine. This is the case of the use of omics sciences in medicine. The objectives of this work are: i) to describe briefly "omics sciences"; and ii) to analyse the impact it has had the application of "omics sciences" in the early diagnosis, treatment and monitoring of many diseases.

Methods

Search strategy and information processing

As an initial step in this work, a bibliographic/bibliometric review has been made following PRISMA guide [3]. Primary and secondary sources have been included in order to know the different medical paradigms followed throughout the history. To optimise the search of the information, several search engines have been used (including portals or databases both generic: "Google Scholar", as well as specific: "PubMed", "Scopus", "EMBASE", "MEDLINE" and "Web of Knowledge"). The keywords used to do the search were: "oriental medicine", "occidental medicine", "personalised medicine", "biological medicine", "genomics", "proteomics", "transcriptomics"," integrative omics". These terms were previously identified through the database "MeSH" (Medical Subject Heading) as suitable descriptors for the realisation of this work.

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Combinations of these keyword with "medicine" were also used to identify as much sources as possible. Finally, it was also necessary to include the keyword "integrative omics" to avoid the loss of studies and clinical trials, in which an integral approach of personalised medicine is done using "omics sciences". All the following options were selected in the databases previously mentioned: "Title/Abstract", "article" and "review". Search finished in July 2016; the language was not specified. The research question was: Which is the role of the "omics sciences" in medicine and the development of personalised medicine?

Data analysis and selection of the articles previously identify

The classical scheme proposed by Vilanova [4], has been used to analyse and to assess the quality of the information obtained. The main conclusions drawn about the evolution of the paradigms of the medicine are summarised in the Figures 1,2 shows the field of action and the object of study of each of the "omics sciences"; Table 1 introduces the general definition of the "omic" disciplines/sciences; Table 2 display the most relevant examples where the integrated approach and multidisciplinary "omics sciences" have allowed to study certain pathologies.

Results and Discussion

Bibliographic sources selected

More than half a million indexed publications (mainly in English) were recorded using the defined search strategy. The most abundant publications were those focused on biological medicine or the occidental medicine, followed by the studies on oriental medicine and, finally, research on the integrated

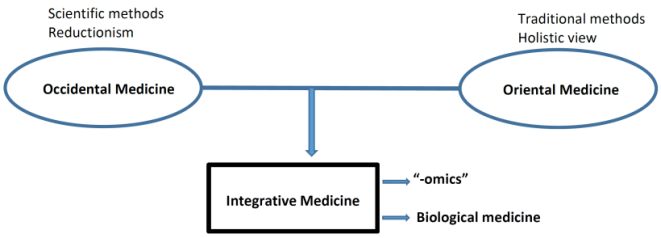

Figure 1: Main paradigms related to medicine.

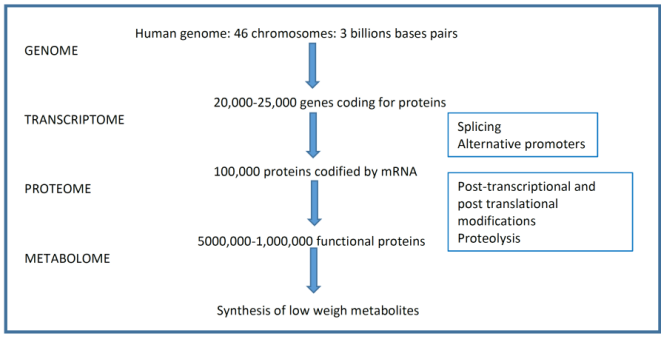

Figure 2: Fields of knowledge related to each omic science.

Table 1: General characteristics of the omics sciences.

Science	Analytical level	Definition	Methods
Genomic	Genome	Genetic material (genes) of one specific organism.	DNA sequencing, Microarrays
Transcriptomic	Transcriptome	mRNA from one cell, tissue or organ.	Hybridisation, SAGE (serial analysis of gene expression); microarrays. mRNA sequencing
Proteomic	Proteome	Proteins from one cell, tissue or organ.	Bidimensional electrophoresis; trypsin digestion; liquid proteomic, Mass spectrometry (MALDI-TOF; NANO-ESI Chip-HPLC-MS/MS)
Metabolomic	Metabolome	Quantitative study of the metabolites (intermediate compounds of low molecular weight) in one cell, tissue or organ.	Infrared spectroscopy; mass spectrometry; NMR (Nuclear Magnetic resonance), EPR (electronic paramagnetic resonance), Raman spectrometry.
Metabonomic	Metabonome	Quantitative study of the dynamic changes of the metabolites concentration in response to one specific stimulus.	Infrared spectroscopy; mass spectrometry; NMR, EPR.

Table 2: Relevant examples where "omic sciences" have been Used to study specific pathologies or to identify new molecular targets for diagnosis. Most of them are examples related to cancer.

Process/Disease
Protein-protein interaction [31]
Hypertension [32]
Renal diseases [33,34]
Tuberculosis [35]
Cardiovascular homeostasis [36]
Endocrine processes [37]
Atherosclerosis [38]
Chronic pulmonary obstruction [39]
Cancer [40-44]
Virus infection [45]
Arthritis [46]
Doping [47]
Process/Disease
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use of the "omics sciences" in medicine. There are not studies on the integrated use of the "omics sciences" before 2002, while the first studies published in any of the other three fields (biological medicine, occidental medicine and oriental medicine) appeared in the seventies (last century). To develop this work, revisions and clinical trials in English and Spanish were selected, which gave rise to a database consisting of 86.722 publications ("integrative omics": 5 clinical trials and 137 review studies; "occidental medicine": 552 clinical trials and 598 review articles; "oriental medicine": 1344 clinical trials and 2121 review studies; "biological medicine": 5629 clinical cases and 76.336 reviews). The bibliometric analysis of all this information confirms that the greater part of the studies focused on oriental medicine were carried out in China, Japan or Vietnam.

Integrative medicine

The existence of a scientific methodology and the development of universal protocols, supported by continuous technical advances have made occidental medicine the dominant paradigm at the global level [5]. Thus, occidental medicine is typically identified as "conventional medicine". Recently, several studies have revealed the existence of several limitations when using occidental medicine to achieve improvements in patients affected by certain pathologies (especially of chronic character). During the last two decades, these constraints, coupled with a growing interest of society by access to a nearest medicine, and to the increasingly widespread rejection to the chemical drugs [6], have force a consensus/collaboration of the two main paradigms of medicine (occidental and oriental), thus trying to reduce limitations and to achieve the maximum benefit of wellness [7]. Thanks to the integration of the main concepts belonging to both paradigms, new disciplines have evolved in which the scientific medicine, (traditionally reductionist) begins to expand its horizons to implement a holistic vision of the individual (Figure 1). This new approach improves the understanding of pathological processes and opens the door to the development of new diagnostic techniques and new treatments (http://sesmi.es/). Thus, the concept of integrative medicine appears, which is closely linked to the concept of personalised medicine. The term "personalised medicine" was used for the first time in the second half of the seventies, last century [8]. Its main goals are to optimise and to adapt the processes of diagnosis and treatment to each patient by making use of the new technologies [9] and the knowledge about the biological role of certain molecules [10-12]. Accordingly, the personalised medicine, seeks to integrative treatments fully adapted and adjusted to the needs and characteristics of each patient. It acts considering many variables and parameters, with the aim of compiling the maximum information available [13].

Within the group of the new integrative medicines, biological medicine and medicine based on "omics sciences" can be also distinguished (Figure 1). Biological medicine, introduced by the scientist C.W. Hufeland, was clearly established in 1940 thanks to the contributions of the German doctor Hans Heinrich Reckeweg [14]. This discipline understands health as a state of equilibrium of the body that can be affected by causes of different nature (environmental factors, emotional state, and accumulation of certain toxic substances or eating habits). The disease is understood as a natural process where the symptoms are a result of the struggle of the natural health balance. Far from to suppress or eliminate the symptoms, it seeks to protect or restore the balance by reinforcing the self-curative capacity of the human body. To do this, treatments intended for activation and the stimulation of the immune system of the patient are used, so that the patients themselves get to remove factors that undermine their health.

Biological medicine uses products of natural origin and therapeutic methods that can be applied combined with the treatments of conventional medicine [15]. Among the methods used by biological medicine, the following can be highlighted: homeopathy, acupuncture, phytotherapy, nutrition, oligotherapy [16], bioresonance and homotoxicology [17,18].

The "omics sciences" based medicine represents the consolidation of the concept of personalised medicine based on the use of genomics, transcriptomics, proteomics, metabolomics and metabonomic, not only for diagnosis but also during the treatment and monitoring. In fact, the uses of "omics science" in medicine reinforce the concepts of natural, personalised and biological medicine. This new way of practising medicine arises in parallel to the development of these new omic disciplines [19], and it is conceived by many authors as the medicine of the future. Thus, "omics sciences" promote early diagnosis and allow to the professionals to get fully detailed metabolic profiles from each patient, who are further treated combining occidental and oriental practises with biological medicine.

Omics Era Impact of -omics sciences in medicine

The "Omics" era begins at the end of the twentieth century, when the technological advance in biochemistry, molecular biology and analytical chemistry enables the development of genomics, transcriptomics, proteomics, metabolomics and metobonomic (Figure 2) [20,21]. These new areas of knowledge are currently recognised as disciplines with their own entity, which are responsible for the detailed study of the genome, transcriptome, proteome, metabolome and metabonome, respectively (Table 1). This technical-analytical boom, among others, led to the development of the called "human genome project" for instance (Https://www.genome.gov/10001772/all-about-the--human-genome-project-hgp/). Since that time, each one of these "omics sciences" has been used separately with the following objectives: i) to establish processes of early diagnosis of diseases (cancer for instance) [22,23]; ii) to search target molecules for diagnosis [24]; iii) to identify the therapeutic or toxic effect of certain molecules [25,26]; iv) to study processes of cellular aging [27] or v) to perform forensic analysis [28].

Recently, the combined use of "omics sciences" has given rise to the " integrative omic", [29,30]. From this integrated and multidisciplinary approach, multiple pathological processes have been studied and new strategies for early diagnosis of

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diseases have designed. Key examples of the integrated use of these disciplines in medicine are shown in Table 2.

Thanks to this new approach in the medical practice, a complete molecular profile of the patient can be obtained [48-50]. This molecular profile can be studied at real time relatively easily thanks to the technological enhancements [51,52]. This leads to the implementation of a fully personalised medicine [53].

Conclusions

In recent years, the biological medicine as well as personalised medicine have raised interest both, among the general population and between researchers and professionals of the medicine. "Omic sciences" have been extensively used to carry out basic and applied science in fields of knowledge related to biochemistry, genetics, molecular biology or biotechnology. Nevertheless, omics are tools/sciences that could be of great relevance in medicine not only for early diagnosis but also for monitoring. Thus, the use of the "omic sciences" in medicine, as isolated disciplines or in combination with each other, has led to a revolution in the way of practicing medicine (much more holistic vision completely focused on the specific health/disease process shown by a patient [48,49]. This new approach allows: i) to identify new biomolecules as markers for the early diagnosis of diseases [24]; ii) to treat complex pathological processes [54] and iii) to estimate accurately and predictive, the capacity that could have an individual to develop throughout their life-cycle a pathology [55]. However, fully personalised medicine completely implemented in the daily practice is yet to come. New alternatives in the process of acquisition of patient data by the physician and other medical personnel, technological advances relating of the biochemical analysis, as well as the optimization of computing platforms and new systems of massive data analysis [56], will allow in a near future the development of a real personalised medicine of accuracy.

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