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Open Innovation in Healthcare Ecosystem – a systematic review

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Abstract

Background: Several countries are facing significant troubles of health services, particularly rising prices. Innovative technologies and services are expected to help boost medical quality and cut costs. In this sense, there is a lack of innovative work in spite of a growing interest in open innovation and approaches that advocate for expanded cooperation among various actors in healthcare.

Objective: This paper describes the findings of a study concerning the commitment of the healthcare sector to open innovation.

Materials and methods: The search for literature focused on English-language papers to 12 January 2020. Based on the indicated criteria for inclusion, 29 articles were included.

Results: Results show that most experiments concentrate on the areas of pharmaceutical research (drug discovery) and health informatics (health information systems and infrastructures) that were brought out as concepts or applied as pilot and prototype.

Conclusions: The participation of the healthcare sector limited in open innovation, and more work is required with an emphasis how to get open innovation.

Keywords

Ecosystem, Healthcare, Health Management, Open innovation, Strategy, Technology

Introduction

Nowadays, healthcare institutions in developed countries face numerous and dynamic environmental and financial problems, such as the lack of trained workers, and the need for openness (Bullinger et al., 2012a). This involves the problem of raising the wellbeing and life expectancy requires of the aging population, the growth of chronic illnesses, and growing customer expectations (Dandonoli, 2013). Around the same time, more pressure is placed on healthcare budgets and it has been suggested that more innovation is needed to provide effective and high-quality healthcare services (Keller et al., 2013). In healthcare systems, innovation is a new collection of practices, habits and operating strategies aimed at enhancing patient quality, institutional performance, expense, or customer experience, and enforced by organized and orchestrated activities (Omachonu & Einspruch, 2010). With respect to innovations, it is claimed that the innovation needs to be new or significantly changed. The different types of innovation apply to production or result, but it is important to note that innovation is not simply an act but a mechanism. Four innovation types are distinguished: organizational, process, products (including services) and marketing. Innovation has become a vital power within healthcare institutions as a means to close the gap between what is feasible, and what is not being done in the current provision of healthcare (Thakur et al., 2012). However, companies have historically focused on internal expertise and competencies in the quest for innovation (Bullinger et al., 2012b).

To maintain existing market positions and ensure success in a competitive market, relying on internal expertise is no longer adequate as information is spread through companies and individuals, and increasingly more qualified people are available, so organizations have difficulty in recruit all the requisite skills (Andersson et al., 2011). As the technology environment has shifted dramatically, so has the view of innovation and organizations gone from innovating within divisions of research and development (R&D) and relying on internal capability to becoming more transparent and inclusive through the participation of a number of stakeholders (Dal Molin, 2011). The company's boundaries with the world became blurred, and companies looked to outside players to discover new ways of seeking creative solutions (Huizingh, 2011). A new approach, called open innovation, has gained attention for its goal of decreasing internal production costs while still rising revenue (Davey et al., 2010). Recently open innovation was identified as a centralized method of innovation focused on intentionally controlled information flows across organizational borders, using pecuniary and non-pecuniary processes in line with the business model of the organization (Chesbrough, 2012). In open innovation the emphasis is on collaboration between different players during the production and promotion of an innovation. That concept of innovation emphasizes the importance of extending the organization's scope, and recognizes that not all innovative innovations can originate from within the enterprise and not all good ideas generated within the company will be effectively internally sold. This helps projects to be introduced in various forms and at different times (Chesbrough & Bogers, 2014).

Because of the increasing need for patient participation, cooperation with other actors is a major task for healthcare organizations to develop and enable expertise and innovations to spill into and out of the innovation process (Lundberg et al., 2013). Innovation seeking to include

internal and external information, in diverse industries such as healthcare, is represented by the idea of open innovation, relating to the need to reach through the organization's conventional borders to develop to make the organization's borders more permeable (Lindgren & Rasmussen, 2013). Application of open innovation in the healthcare has a wide variety of meanings. Health open innovation includes health care innovations, as well as innovations in disease prevention and health promotion. It could come in the new form of services, products, processes, organizations, or policies. In fact, some of these are often involved at the same time. For example, the successful introduction of new technological innovations could require the development of new roles for patients, complementary technologies, new processes, new business models, and policy changes (Keller et al., 2013).

Given increasing academic interest in open innovation, the approach to the healthcare context is constrained and less discussed as a way to study transparency and collaboration in healthcare, and open innovation analysis in healthcare contexts is currently gaping (Wass & Vimarlund, 2016). To the best of our information, there was no systematic presentation of the Implementing open innovation in the health care industry. Therefore, in the context of healthcare, more emphasis is needed on open innovation. The purpose of this review is to summarize current work and present it on the commitment to open innovation in the healthcare ecosystem.

Methods

A systematic review was performed of the literature to fulfill this study's research objective. This review followed the authors reporting a systematic review of the PRISMA guidelines.

Information Source

Studies were identified to 12 January 2020. They were selected by searching the online databases PubMed, Web of science, Scopus, and Embase, and Search Google Scholar. Searches included online books, published papers, conference abstracts and seminar and reference publications to avoid bias in publishing and to ensure that as many articles as possible were included. Additionally, the selected articles reference lists were searched for other relevant studies. In addition, the bibliographies of articles and reviews published were searched by hand for potentially relevant articles. An online archive email warning feature was developed to keep track of any newly released publications that meet the selection criteria based on the saved search history by 12 January 2020.

Eligibility Criteria

Reviewers separately appraised the titles of the papers. The publications were classified into a category "definitely remove" and a category "probably include;" the abstract of any of the papers likely included was assessed. Studies that contained abstracts that did not meet the criteria for inclusion were ruled out. The entire text of the remaining articles was assessed and duplicate articles were deleted. Articles were eligible when they reported instrument development, validation or translation studies of open innovation in health area. In addition, only articles written in English were included, and from which full text access was available. Letters to the editor, commentary, review and opinion papers were also excluded. There was no limit on publishing year.

Search

The search terms were derived from the concepts in the research objective: open innovation, medicine, medical, care, health, healthcare and health care. This resulted in the following syntax.

(“open innovation” AND (health OR medicine OR medical OR care OR healthcare OR “health care”))

Potentially relevant papers were selected first based on title and imported into the Endnote. Further selection was performed on the basis of the papers' abstract and full text.

Article Selection

An overview of the selection process for the entire article is shown in Figure 1 of the PRISMA flow chart. Two hundred and two articles based on title were selected. They analyzed the abstracts and excluded 133 articles as they did not meet the eligibility criteria. By reading the full text, the remaining 69 articles were further assessed as eligibility. 40 were excluded from this. Finally, 29 articles were included in the analysis.

Data Collection Process

The type of study had been determined for each article. It was followed by extracting information according to various templates appropriate for these types of research studies, discussed in the next section.

Data Items

The full text of the chosen articles was then independently reviewed by the reviewer. The standardized data extraction form was used to extract the data from the selected articles. The data extraction sheet for each study included the authors and year, country, research type, aim of research, stakeholders, key findings, open innovation context, open innovation outcome and stage in the open innovation process. All results were collated from the selected studies. Another independent investigator reviewed and verified for completeness and consistency of all data entries.

Quality Assessment

The consistency of the initially chosen research was assessed and analyzed to support the inclusion / exclusion process. The essential testing method used was a fairly modern checklist intended to evaluate mixed tests of reliability and validity, or to measure validity and reliability as independent elements. There are 13 points on the checklist. This tool was developed using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) tool and the Quality Appraisal of Reliability Studies (QAREL) tool. Two researchers have analyzed all of the identified research for threat of bias. Researchers were judged to be of good standard because they earned 60%. All differences were overcome by agreement.

Results

Search Results

Figure 1 presents a flow diagram based on the PRISMA guidelines, which details the movement of articles through the review process. In total, 5295 titles were retrieved from the databases and 1859 titles remained after duplicated articles were removed. Two reviewers screened the titles and abstracts for relevance, and 1657 articles were deemed irrelevant to the review topic and were excluded. Two hundred two articles were selected based on title. The abstracts were analyzed and 133 articles were excluded as they did not meet the eligibility criteria. In total, 69 full-text articles were retrieved and assessed according to the eligibility criteria. After the assessment, 40 articles were excluded (refer to Figure 1) and 29 articles were included in the review.

Figure1.PRISMA flow diagram

The issue of open innovation has grown exponentially in recent years and has attracted the attention of researchers around the world. Comparing the open innovation topic and health open innovation shows that the extent of open innovation is much greater than the health open innovation (Figure 2, 3), but nevertheless the results of the study show that this topic has been raised in the field of health from 2010; and now it is one of the topics of interest to researchers (Figure 4). As can be seen in Figure 6, most of the studies are in the fields of pharmaceutical sciences (drug discovery) and health informatics (health information systems and infrastructures) that have been put forward as ideas or implemented as pilot and prototypes as well as most of these studies had product and service outcome. Consequently, words such as drug, platform development, model, and framework were used more in the studies. Also, all citizens, patients, and health care providers and managers have also been identified as stakeholders in most studies. Further studies were of the conceptual and Practical type that belonged to European countries such as Germany and Sweden. Among other countries, the United States has done well in this area (Figure 5).

Figure 2. (A) The growth trend of articles in the field of open innovation (B) Geographical scope is the subject of open innovation in the world

Figure 3. The Comparison of the trend of open innovation and health open innovation

Figure 4. The rate of health open innovation articles based on years

Figure 5. The rate of health open innovation articles based on countries

Figure 6. Frequent words cloud based on finding

Characteristics of Included Studies

Table1. Details of the studies selected in this review

Discussion

In recent years the demands for managing innovation have changed dramatically. In the conventional understanding the in-house R&D department is the most significant source of creativity. Opening up to the outside world to better meet the growing demands changes this traditional understanding (Kratzer et al., 2017). The distinction between open innovation and closed innovation lies in how innovation is created. While in a self-contained enterprise environment a closed innovation is created, Open Innovation integrates external information into

innovation management. A closed innovation is based on assuming that innovations are produced by the companies themselves. The innovation process is carried out exclusively within the company, from idea generation to development and marketing. Thus, it is impossible to open to the outside. Innovation is developed within the framework of the firm's clearly defined limits. Company know-how, technology, processes, and intellectual property remain under innovative control. Certain factors must be taken into account in order to implement a closed innovation successfully within the company. Closed Innovation, for example, sets very high employee demands so the company should always aim to recruit highly qualified employees. Protection of one's own intellectual property is also important (Alawamleh et al., 2018).

Open innovation involves opening up the innovation cycle outside client limits to maximize one's own creativity capacity through the successful strategic usage of the environment. While innovation emerges from the combination between internal and external concepts, techniques, procedures and networks between distribution with the company's goal of developing promising, innovative products, services or businesses models. It is possible to integrate own employees, customers, suppliers, LEAD users, universities, competitors or firms of other industries. However, sharing information and networking know-how that is characteristic of open innovation does not mean free access to a company's expertise and technologies. The word pertains only to social networking. Hence, open innovation will entail high license and other intellectual property costs (Comai, 2019).

The closed form of innovation has become increasingly less important in recent years as well as the importance of open innovation is steadily increasing. According to the studies the following variables are responsible for this growth: Highly trained professionals are becoming increasingly accessible and more interactive. Invest capital supply is on the rise. An innovative environment for a company offers opportunities outside of potentially unused innovations. As collaboration partners the increasing number of professional consumers and specialist suppliers available. A company's creative ecosystem is therefore progressively relevant, and the standard and quantity of external know-how is continuously rising (Svirina et al., 2016).

Although the value of open innovation is increasing, proceeding pursuing a closed approach to innovation or a combination of open and closed innovation can make sense for a company. In turn, whether an organization chooses open or closed experimentation as part of its product policy has three factors to depend on: a) Complex innovation: transparent innovation will bear some hazards because innovations are strongly linked; it may contain improper elements that impair the innovation mechanism itself, or even adversely affect the whole product line. b) Unique innovation: Closed innovation is generally favored when an innovation makes profound technical advances that offer the business an unassailable edge over its rivals. Open innovation thus works better where creativity is a continuous process where gains can be produced by collaboration. c) High competition: Closed innovation is usually better suited in industries with intensive competition to exploit the benefits for the company itself (Felin & Zenger, 2014; Marques, 2014).

Open innovation literature stresses the need for companies to collaborate with other players in order to identify new innovations and tools to remain successful, which can be represented by three separate key processes or practices. The first method, called inbound process, enhances the organization's creative ability by incorporating information from outside players into the internal knowledge base. The emphasis is on providing quality facilities

leveraging business, academics, vendors and client's expertise. The second form is the inside out process, also referred to as outbound process, which focuses on income generation by moving internal, creative ideas to outside actors. The coupling process which focuses on combining the processes outside and inside by establishing alliances with complementary external actors is third type of process. Recognizing that an innovation cycle is not necessarily opened or closed, is critical. Therefore, open creativity is something like a continuum of increasing degrees of openness (Gassmann et al., 2010).

Generally, open innovation provides opportunities for creativity, as it leads to developing one's own entrepreneurship awareness. Open creativity, however, is not only a "replacement" for closed innovation but can be treated as complimentary. However, stable internal innovation structures and processes are the requirement for an opening up to the outside world to successfully integrate and utilize external knowledge (Lopez-Vega & Vanhaverbeke, 2009).

The consequence of most open innovation projects in healthcare, as can be seen in most studies, is service. Overall, however, the study of innovation often relates primarily to the notion of service, which is considered the key element of the modern service economy and the so-called innovation in services. Service innovation is a kind of open innovation which has recently gained popularity (Berry, 2019). Given the increasing economic importance of the service sector, service innovation plays a vital role to accelerate development in a knowledge-intensive economy today (Ciasullo et al., 2017). Such form of innovation is sensitive to enhanced consumer feedback, interactivity and specialization; is multidimensional in nature; and incorporates economic, efficiency, and production dimensions. Increased consumer interactivity services provide expanded incentives for innovation by experiences requiring enhanced information exchange and learning activities and these higher-order skills lead to service innovation (Bitner et al., 2008).

As the details in this essay demonstrate, service innovation is not only feasible but also necessary in healthcare. Traditionally, the healthcare industry has not encountered significant external competition to be successful in-service delivery, but it does so now (Barrett et al., 2015). Wasteful expenditure is widespread and there is an immense demand to control costs. Business conditions are increasingly evolving, and economic stability for a healthcare institution is no longer a guarantee. Non-traditional competition and non-traditional technologies, among other market factors, need a broad-based effort to increase performance and clinical and service quality, in order to meet the demands that most consumers today have when they view healthcare progressively through a customer lens (Lusch & Nambisan, 2015). The complexity of healthcare as a company raises difficulties in introducing service innovation. However, local hospital services have simply, operationally and effectively, taken on the role of the innovation service. That remains for this necessity is to propagate more broadly and more consistently, including experts in the area of communications, such that attending to the "customer experience" is one of the key priorities on how healthcare is provided worldwide (Joiner & Lusch, 2016).

Examination of the present study shows that drug discovery is the one of the most important needs of the healthcare sector, which led to the creation of open innovation. Open innovation has not come to the pharmaceutical industry of course. While in the early 2000's the consumer goods and manufacturing industries rapidly embraced open innovation, the pharmaceutical industry needed an extra push. This extra push came in the form of patent

expirations (Munos, 2009). In the past years the pharmaceutical industries to develop new drugs is slow and have not productivity. The reality is that costs have escalated, and hence investment in R&D, with no concomitant increase in return on that investment (Coopers, 2007). The current success rates of the pharmaceutical industry are still not enough to sustain large internal R&D organizations, making the current operating model of the industry financially non-viable. Therefore, companies are seeking new avenues to either increase their level of innovation, cut costs or reduce risk. This situation pushed them towards embracing open innovation. Not for wanting to, simply because they had to. Faced with the highest failure rates in any industry, unprecedented discovery and development costs, heightened competition, the patent cliff and the increasing complexity of therapeutic intervention methods, biopharmaceutical companies had virtually no choice but to adopt open innovation in some way (Hunter & Stephens, 2010). It is very early, but there are signs that large pharmaceutical companies are prepared to move towards a more flexible and open way of working. But there are also barriers to the industry fully embracing this new way of working and adding it to other models for externalization. Perhaps the greatest obstacles to the full open pharmaceutical innovation implementation are cultural, and strong senior internal leadership in companies will be needed to ensure the necessary changes in mentality and behavior are encouraged (Munos, 2010).

A second reason for creating open innovation in this field is the need to create connected health in the health care sector. In recent years the connected health concept is gaining traction as a new technology has enabled and networked the delivery model of health care. It is also used as a generic word for eHealth, digital health, medical informatics, telemedicine, mHealth and includes building up and maintaining a network of partners with a view to enhancing the standard and results of medical care (Priyadarshini et al., 2017). However, the absence of open exchanges and information networks and the lack of integration with the broader population with interdisciplinary expertise hinder the implementation of the model and restrict the ability to establish programs and strategies using common health-related evidence across the needs of patients. Communication by stakeholders in an open innovative format in the health care ecosystem removes constraints and maximizes the concept of connected health (Kemppainen et al., 2019).

Another concept that was mostly observed in studies was the living lab. Living Labs become networks of innovation focused on the open innovation paradigm under which consumers are equal to all participants (Almirall & Wareham, 2008). Living labs can be classified in three major types: Living labs to learn and play with omnipresent computation, Living Labs as open platforms for innovation and Living Labs to expose testbed applications to users (Santoro & Conte, 2009). This awareness will allow them to recognize which actor drives creativity, to predict probable outcomes, and to determine what kind of role they should play when "living lab". Living labs are networks that can help them to create innovations that match the needs of the user and can be upgraded to the global market promptly. By living labs, we mean the space of interaction being reconstructed. It can be any place, wherever, appropriate for the use of innovation for collaborative design, the application of knowledge for empowerment, enhancement and growth of citizens and communities (Leminen & Westerlund, 2012).

In scientific there are four specific forms of living labs that can be classified by the person guiding the activity and creativity activities of the network. These types are: user-driven, enabler-driven, supplier-driven, and user-driven living labs. The intent, the logic of value-

creation and the results differ among the types. Participation in living labs can further assist companies in creating innovations that meet the needs of users and can be upgraded to a global market in a short time (Schuurman et al., 2016).

Conclusion

We discuss and address the usage of open innovation to healthcare environments in this report. The research indicates that open innovation is the main result, with innovative health information systems and products. At its initial level, the innovation process was researched, though also in innovation networks. Several scholars advocate for a step toward open healthcare innovation as a way to promote the possibilities of healthcare information systems. Even this review reveals that in changing conventional organizational boundaries and the role of supplier and customer the healthcare sector has been slow. The move from closed to open innovation has been described as a paradigm change in which it is important to turn from control to openness and evaluate processes in order to grab interest and produce value. A general conclusion from the report is that it suggests that open innovation research is at a premature stage in the healthcare sector. Even though the research concentrates on the promising results and challenges that impede open healthcare progress, they did not examine in detail and empirically whether open innovation has been placed into practice or what benefits and prerequisites there are for stakeholders. Consequently, more work is needed with an emphasis on how to handle open innovation in healthcare.

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Declaration of Interest Statement

Authors declare that they have no conflict of interest.

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Table 1. Details of the studies selected in this review

Authors and Year	Country	Research type	Aim of research	Stakeholders	Key findings	Open innovation context	Open innovation outcome	Stage in the open innovation process
(Pieroni et al., 2017)	Italy	Mixed	To pursue a campaign of medicinal chemistry on one of the malaria boxes compounds.	Malaria Patients and Pharmacists	<ul style="list-style-type: none"> The important structural features and compounds' mechanism of action were discovered. Molecular target(s) remained unknown. 	Development of Medicinal chemistry campaign on one of the compounds of the malaria box	Service	performed
(Hussey et al., 2019)	Ireland	Action research	To discuss the specified organic implementation criteria of the meta data registry architecture and the key catalogs generated for cross-border delivery on identification, self-management assistance and overview care records.	All citizens and health care providers	<ul style="list-style-type: none"> To align with cross-border initiatives such as the eHealth Digital Services Infrastructure Open National Contact Point Program, three metadata catalogs relating to patient data, document data, and clinical data were created. 	Development of a meta data registry to support an integrated care interoperability framework in the form of a Health and Social Care National Data Dictionary	Service, product	in process
(Richter et al., 2019)	Germany	Qualitative	To address future challenges in rural areas through digitalization approaches.	Rural Citizens and health care providers	<ul style="list-style-type: none"> Initially two implementation projects are planned for the regional digital strategy. This will include a collaborative, multifunctional online portal for the Northern Black Forest area. 	Development of a future-oriented digitization strategy with a focus on local supply, health-related care and	Service	Idea

					and digitized services in the pilot region's local centers.	residential mobility		
(Allarakhia, 2015)	Canada	Conceptual	To suggest that patients be involved in all stages of drug discovery.	All patients, healthcare providers and Pharmacists	<ul style="list-style-type: none"> It is important that researchers consider how patients interpret the treatment of their diseases and how they interpret the use of traditional and non-conventional treatments. It will also provide insight into how current interventions can be organized from the outset to promote compliance and beneficial safety outcomes. 	Engaging patients across the drug discovery spectrum	Service	Idea
(Baltes & Gard, 2010)	Germany	Conceptual	This paper discusses Living Labs' intermediary role in the frameworks of open innovation.	All citizens, healthcare providers and academic people	<ul style="list-style-type: none"> Not only lead users and technology providers but entrepreneurs also play a vital role in the implementation of the Living Lab process. Living Labs may be subdivided into Micro Level and Macro Level Living Labs. Macro Level Living Labs should focus on establishing clustering effects on a large-scale, using virtualization skills. In comparison, micro-level Living Labs will focus on enterprise support for individual cases. 	Development of Living Labs that provide the necessary infrastructure to establish clustering effects without any geographical restrictions	Service	Idea

(Biancone et al., 2019)	Italy	Qualitative	To create a new framework which includes both cycle theory and the micro costing approach and provides results for health managers and health decision-makers.	health managers and health decision-makers	<ul style="list-style-type: none"> The use of the innovation process and the principle of micro-costing allows cost management and reduction, taking into account patients' key priorities. The convergence of the two hypotheses is a more obvious fact because, on the one hand, there is a need for medical records to incorporate a data management system and, on the other, a need for accurate calculation of costs per patient. 	Development of efficient accounting and information system able to process, store and share data.	Service, product	Idea
(Chaher et al., 2017)	France	Action research and conceptual	This paper addresses the intermediary role of Living Labs in Connected Health Lab as open innovation processes.	All citizens, healthcare providers and academic people	<ul style="list-style-type: none"> Constructed a Meta model with the structure of two concentrated spheres (a spherical core and a concentrated first layer). The central part represents the innovation meta model, and the peripheral part represents the one of open innovation. 	Development of Connected Health Lab	Service	Prototype
(Carroll et al., 2017)	United States	Action research and conceptual	This paper proposes a practical dashboard for assessment, improvement future performance and decision-making.	All patients, healthcare providers and Pharmacists	<ul style="list-style-type: none"> Promote the sharing of knowledge with external participants while maintaining the security of their IP. Pave processes in place to track opportunities generated. Interact with internal systems to recognize their complementarity with conventional R&D efforts. Provide the ability to rapidly implement new modules as the program offerings develop over 	Development of Drug Discovery program and global leading indicator dashboard incorporating qualitative and quantitative metrics	Service, product	Pilot

					time.			
(Davies et al., 2019)	Wales	Action research and conceptual	This paper presents an approach to open innovation for the commercialization of health and social care services.	All citizens, Government, NHS, universities and private sector	<ul style="list-style-type: none"> AgorIP offers a creative marketing strategy by co-creating innovation that highlights Open Innovation as an approach to orchestrating opportunities from a variety of outlets and also demonstrates a way to tackle the ongoing issue of absorptive capacity in the core components of the health care system. 	Development of AgorIP, novel technology transfer approach that empowers citizens to manage their personal and collective health and access to information and services	Service, product	Pilot
(Weng & Huang, 2017)	Taiwan	Quantitative	To examine from an open innovation point of view the effect of experimentation and exploitation learning on organizational innovativeness among health service organizations.	Top managers of hospitals inclusive of Superintendent, Vice Superintendent, and chief of departments	<ul style="list-style-type: none"> There is open innovation in the hospital sector, but realized absorptive capacity (RACAP) is a critical capacity for directly enhancing hospital innovation. Discovery learning is the most successful learning style, which enhances RACAP at a hospital and increases the scope and depth of external expertise to further strengthen RACAP. However, with exploitation learning, which only has a slight influence on RACAP by mediating the depth of external knowledge, it is difficult to effectively improve innovation in hospitals. 	Exploration and exploitation learning on organizational innovativeness among hospitals	Service	Idea
(Bullinger et al., 2012a)	Germany	Action research and conceptual	This research uses a design science approach to study an open innovation platform for rare diseases.	Patient with rare diseases and family members	<ul style="list-style-type: none"> The platform is built on state-of-the-art information and communication technology and is designed to be available from anywhere and anytime, thus facilitating asynchronous interactions between the local participants. The operation of the platform was found to 	Development of open innovation platform for field of rare diseases	Service, product	Pilot

					support collective creativity and to be emotionally beneficial to the participants.			
(Meersman & De Leenheer, 2012)	Netherlands and Australia	Action research and conceptual	This study introduces a methodology for collaborative innovation use of service value networks in the ambient assisted living domain.	elderly and disabled people	<ul style="list-style-type: none"> System consists of domain elicitation and modeling, elicitation and laddering requirements, atomization, recombination, deployment and monitoring. 	Development of Home Care Systems for Ambient Assisted Living	Service, product	prototype
(Conrado et al., 2017)	Netherlands	Conceptual	To provide a framework, model and workflow for sharing pharmaceutical data.	Pharmacists	<ul style="list-style-type: none"> Improved reuse efficiency, and increased reliability of scientific results through increased transparency. 	Sharing of Pharmaceutical data for Pharmacometric	Service	Idea
(Bullinger et al., 2012b)	Germany	Action research and conceptual	To investigate the adoption of an open health platform by patients, care givers, physicians, family members, and the interested public.	patients with rare disease and general public	<ul style="list-style-type: none"> Open healthcare innovation practices led to positive results for research and were well embraced by the participants. Empathic support and knowledge sharing are important elements of network communication. 	Development of open health platform (GemeinsamSelten).	Service, product	prototype
(Dimitriu et al., 2015)	Romania	Conceptual	They re-designing the courses on medical informatics and data processing.	Producers, customers, users, education and research bodies, other	<ul style="list-style-type: none"> The development of the training approach achieves the goals of preparing specialists, improving cooperation between stakeholders and specialists, and thus focusing more on health information and content, and improving quality and efficiency. 	Re-designing the courses on medical informatics and data processing by employing public Internet services and media facilitation.	Service	Idea
(González et al., 2018)	Andalusia	Action research	This article explains understanding in mobile	Engineers, doctors, nurses and chronic	<ul style="list-style-type: none"> The application promoted multidisciplinary cooperation with health professionals. 	Development of tailored mobile application to address a complex problem such as low treatment	Service, product	pilot

			health innovation.	obstructive pulmonary disease Patients		adherence in the patient with chronic obstructive pulmonary disease		
(Davis & Richard, 2014)	United States	Action research	This paper describes the open innovation achievements and collaborative ventures built over period.	All citizens	<ul style="list-style-type: none"> Novel innovative strategies were applied not only to promote the NASA mission but also to tackle global public health problems. The use of open innovation has led to significant progress towards achieving NASA's human health and performance goals. 	Development of equipment for accurate tracking of medical consumables in flight, compact Aerobic Resistive Exercise Device, Non-invasive Measure of Intracranial Pressure, Hip Bone Microarchitecture Measurement, pursuit of one to several novel strategies to increase medication stability that would enable health care in remote terrestrial settings as well as during space flight, mobile health application that can perform eye refraction exams that could be utilized in space flight as well as in remote settings on Earth and dry electrode vest that can send an ECG signal wirelessly to a smartphone.	Service, product	Performed
(Lundberg et al., 2013)	Sweden	Action research	To create new mobile citizen e-services that allow patients to follow, own and manage their care process related information.	All citizens	<ul style="list-style-type: none"> Access to public e-health services was provided to end users. A number of challenges, mainly related to legal and business issues, persist when implementing results. 	Development of "My Care Pathways" project which envisions enabling citizens to track their own health by providing them with online access to their historical, current and prospective future events.	Service, product	pilot
(Andersson et	Sweden	Conceptual	To create an open and subsidized radical innovation	All citizens	<ul style="list-style-type: none"> Science Park, have created positive innovation which have been beneficial to the whole of 	Reorganize the established "Science	Service	Idea

al., 2011)			arena that can counteract today's development imperfections and also be profitable to the society as a whole.		society.	Park's innovation model.		
(Bouchard et al., 2018)	United state	Conceptual	How can improve the impact and the exploitation of health assistive technology? In this paper, they will try to investigate this question and propose some guidelines based on experience.	All citizens	<ul style="list-style-type: none"> Use this approach greatly increased efficiency and capability of producing usable tools. 	Development of health assistive technology	Service	Idea
(Dandonoli, 2013)	United States	Commentary	To investigate of new models of collaboration in health.	Maternal, Newborn and Child	<ul style="list-style-type: none"> Innovations benefiting from knowledge, community feedback, and multidisciplinary teams from both developing and developed world environments may contribute to goods and services that reach more people faster and generate social and economic value in both settings. 	Development of global collaborations in health	Service	Idea
(Dove et al., 2012)	Canada	Conceptual	This article advocates for evidence-based analyses for understanding of the new dual configuration of postgenomic pharmaceutical R&D.	Patients and Pharmacists	<ul style="list-style-type: none"> Omics science-driven population databases and biobanks help to allow the discovery and validation of reliable, large-scale, high-throughput biomarkers. "Transfer problem" hinders the complete realization of concrete human health 	Taking advantage of omics sciences, population databases and open innovation models for the discovery and development of theragnostic drugs	Service	Idea

					<p>applications in omics science.</p> <ul style="list-style-type: none"> • Its inclusion will likely spur a variety of ethical, legal, and social issues, including those related to consent, privacy, and property. 			
(Jokubauskienė & Vaitkienė, 2019)	Lithuania	Conceptual	To expose the complexity and scope of the incorporation of customer information within the health-tech sector's open innovation cycle.	All citizens	<ul style="list-style-type: none"> • Effective use of consumer knowledge in the organization in the form of open innovation process improves awareness and ability. After that, organizations become more flexible and have a consistent competitive advantage. 	Development of customer knowledge integration in health	Service	Idea
(Keller et al., 2013)	Sweden	Qualitative	To describe and explains how open innovation concepts, mainly arising from the development of commercial products, may be extended to open service innovation in non-profit health institutions.	Patients	<ul style="list-style-type: none"> • Health care institutions need to change their culture and empower patients to participate more effectively in treatment by increasing their awareness. 	Empowerment of patient with open innovation approaches	Service, product	Idea
(Kim & Kim, 2018)	Korea	Conceptual	This study identifies factors which have a positive effect on the performance of organization.	Healthcare IT Small and medium-size enterprises (SMEs)	<ul style="list-style-type: none"> • It is necessary for small and medium-sized enterprises to aspire to develop high technology but it is also beneficial for them to cooperate in the marketing process with other companies. 	In the manufacturing process, SMEs collaborate with other companies, not as a closed innovation but rather as an open innovation.	Service	Idea
(Priyadarshini et al., 2017)	Ireland	Conceptual	In this paper they outline the practice of open innovation in health care and suggest connecting stakeholders in	All citizens	<ul style="list-style-type: none"> • connected health is often used as an umbrella term for eHealth, digital health, health informatics, telemedicine, mHealth and involves the establishment and management of a network 	Development of connected health.	Service, product	Idea

			the health care ecosystem in an open innovative format.		of stakeholders with the aim of improving health care quality and outcomes but it is a complicated.			
(Shin & Park, 2019)	Korea	Conceptual	To provide the basic information for the creation of a 'lab to market' connecting the future cosmeceutical laboratory to the market.	All citizens	<ul style="list-style-type: none"> The process of using open innovation in creating products with positive results was confirmed. The anti-aging industry is expected to expand internationally. 	Construction of product for antiaging	Service	Idea
(Wassrin et al., 2015)	Sweden	Qualitative, explorative and interpretive case study	To describe and characterize an open competition for innovation to improve healthcare, and to address the challenges involved.	All citizens	<ul style="list-style-type: none"> The identified challenges include achieving a common view, sharing of knowledge, managing different agendas and being open to new ideas. At the collaborative stage, the challenges involved the design of the contest, enabling the sharing of knowledge, managing different agendas and being open to new ideas. 	Use of IT based open innovation for improving healthcare	Service	Idea
(Wu et al., 2016)	Australia	case study	To increase the understanding of how firms in the pharmaceutical industry can more effectively identify valuable and profitable innovations and identify the issues and challenges posed by current managerial decision-making practices.	Diabetic Patients	<ul style="list-style-type: none"> A greater understanding of the potential risks of decision making and the introduction of a comprehensive evaluation system would lead to better decision support, resulting in higher quality product selection and growth and improved health outcomes. 	Anti-diabetic drug in-licensing decision	Service, product	pilot

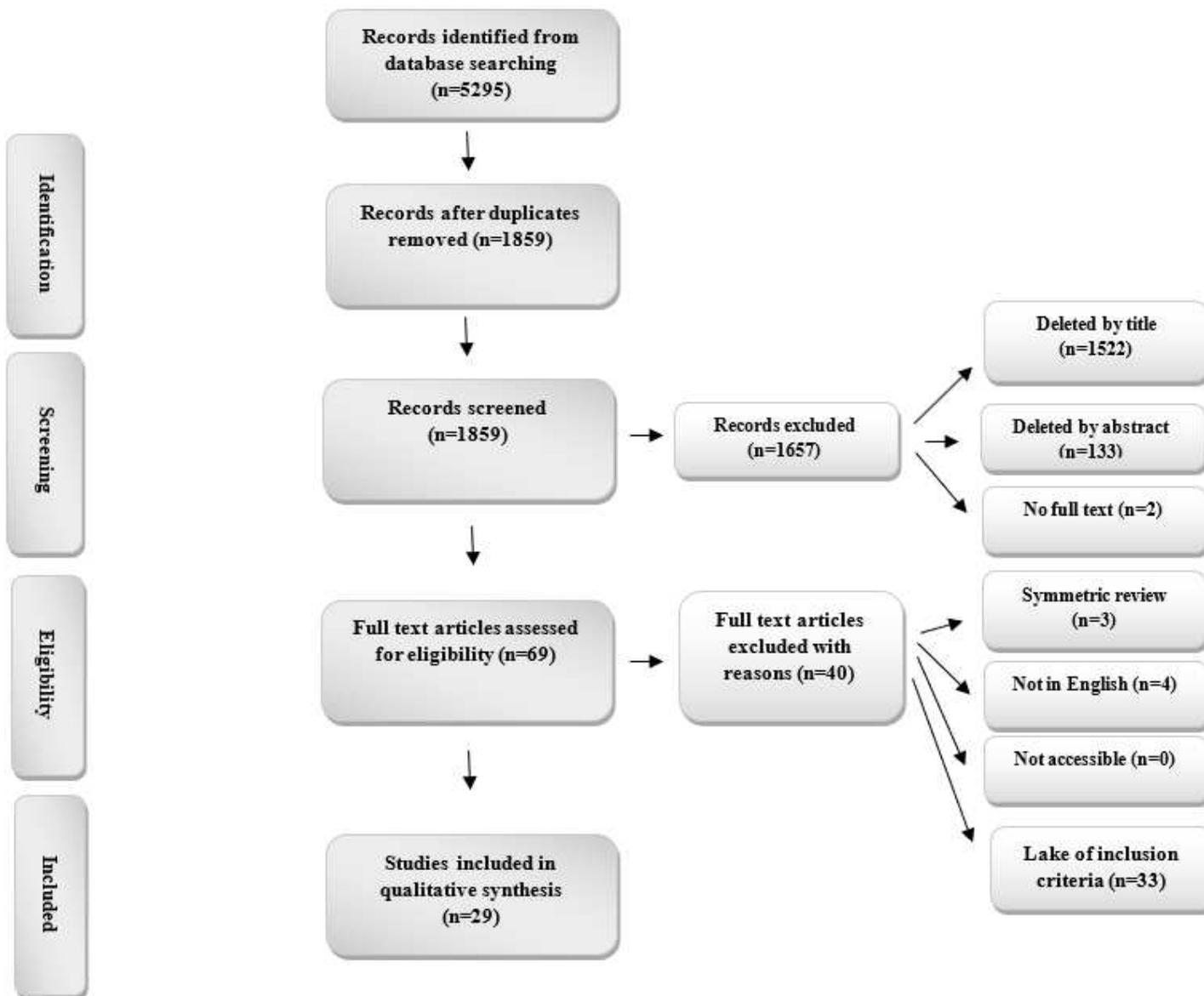


Figure1.PRISMA flow diagram

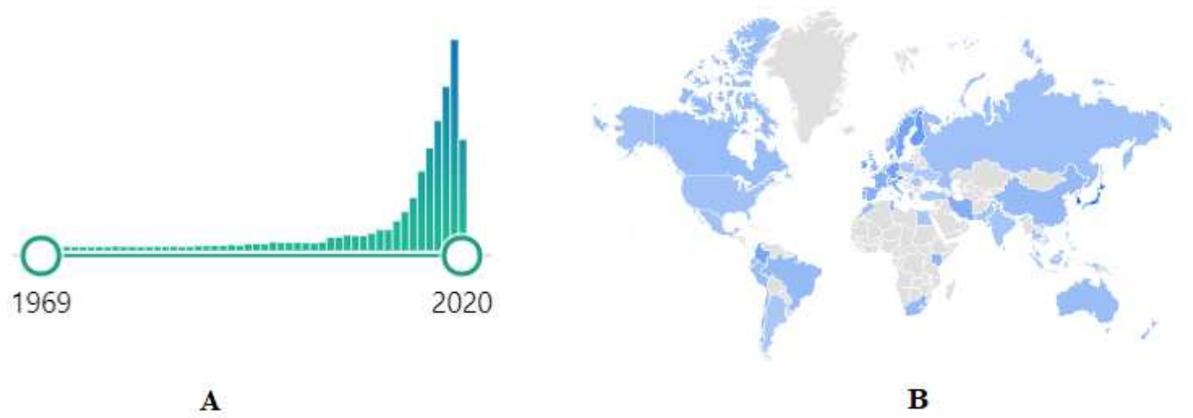


Figure 2. (A) The growth trend of articles in the field of open innovation (B) Geographical scope is the subject of open innovation in the world

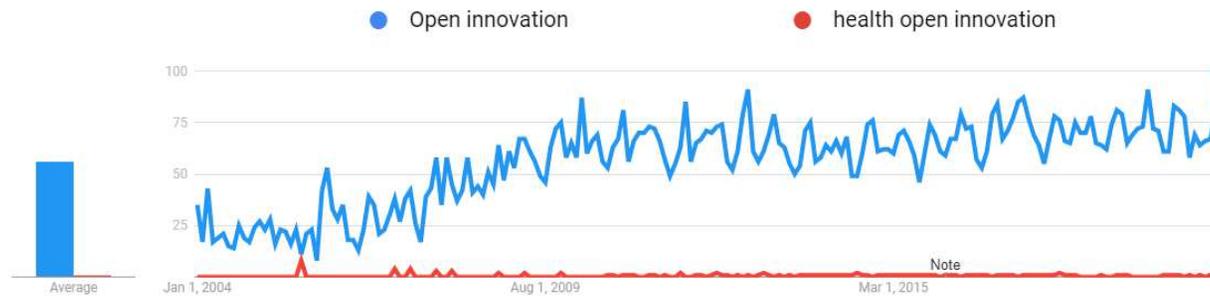


Figure 3. The Comparison of the trend of open innovation and health open innovation

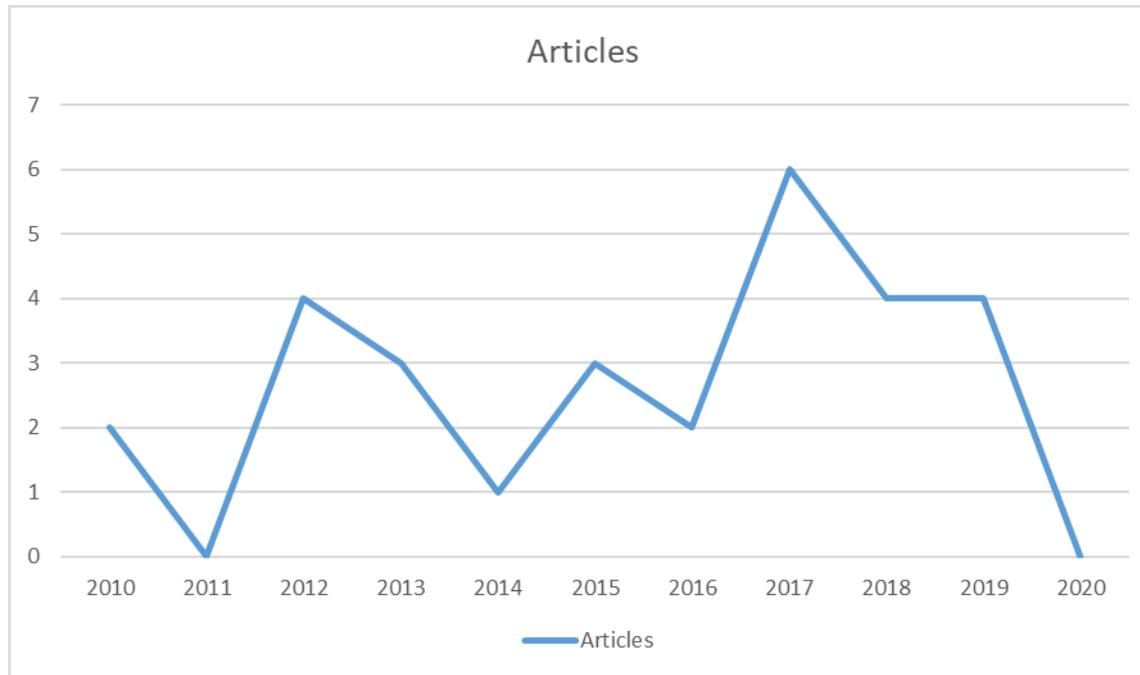


Figure 4. The rate of health open innovation articles based on years

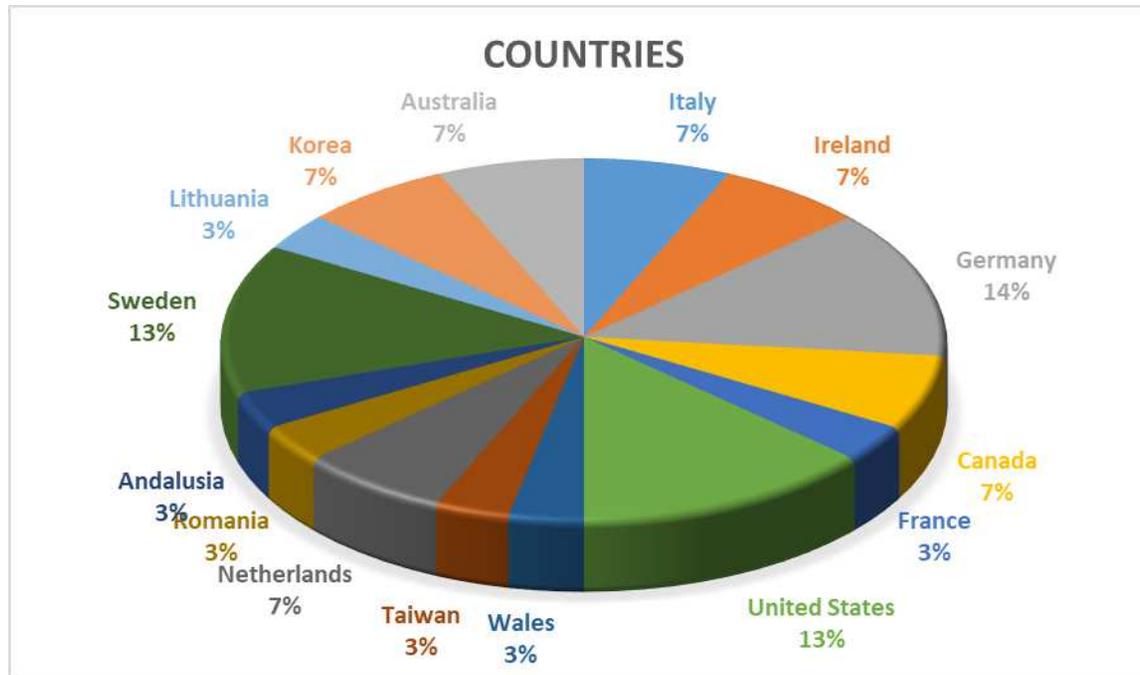


Figure 5. The rate of health open innovation articles based on countries

