

## **Healthcare 4.0: Interprofessional Education, Practices, and Competencies**

This research study aims to analyze the insertion of the nurses in the healthcare 4.0. The study was done from May to November 2018. This study analyzes the Brazilian case as an example for all the countries of Latin America. The study selected three pillars with the higher and three pillars with lower scores. The results section presented three aspects of the Global Competitiveness Index of the World Economic Forum about the human resources analysis healthcare 4.0: the interprofessional education, the practices, and the competencies. The study analyzes and discusses these aspects under the scope of the innovation possibilities offered by the healthcare 4.0. The nurses are transformation agents of their own careers, they should introduce the healthcare 4.0 in their practices, and establish relationship with the professionals of other areas.

**Keywords:** Nursing; Human Resources; Technology; Healthcare; Education; Competence

### **Introduction**

The fourth industrial revolution comes to the world scenario bringing opportunities in the environmental, social and economic fields <sup>(1)</sup>. Historically, since the 18<sup>th</sup> century, when the first industrial revolution took place with the arrival of the steam machines, many changes with the manufacturing have happened. It has brought many chances for development and opportunities. The same happened during the time of the second industrial revolution (1870) with the introduction of the electric energy and the mass production. On the third stage, called third industrial revolution, the information technology and the electronic equipment are inserted on the factories, starting the automated production <sup>(2-3)</sup>. In any of these industrial revolutionary times, not only the opportunities, but also the challenges were experienced. At this moment the fourth industrial revolution allows models for the production, the management, and the practicality for all the population day by day living <sup>(2)</sup>.

It is relevant to observe that the healthcare system around the globe receives and absorbs technological innovation through all the steps of the patient journey. Some examples are present from the check-in until the check-out of the patient in the healthcare institutions. The automation, the digital information, and the connectivity between the systems are daily integrated process <sup>(4)</sup> to work processes and surgical procedures. Therefore, the interaction is observed among the communication, the education, and the information systems. The healthcare institutions when insert and absorb the fourth industrial revolution are named as healthcare 4.0.

The analysis of the healthcare institutions worldwide brings a reflection around how and how much Brazil and Latin America are involved in the fourth industrial revolution context. The ethical, political, and economic crises involving Brazil allowed these challenges. There are multiple challenges to be overcome, either, the environmental, the social, and the economic. Some of them are the continental dimensions and the cultural diversity.

The social challenge includes the unemployment possibilities brought by the fourth industrial revolution, but at the same time, it opens doors for professional innovation. Professional innovation is an opportunity and unemployment is a challenge. Thinking about the machinery replacing the workforce, it is possible to say that machines will demand men who will program them and make preventive and corrective maintenance. In order to do so, it is necessary to provide the adaptation, the capacitation, and the relocation features. A favorable purpose is created for the independent use of the equipment, whenever a potential risk for the health is present. This purpose balances the risks and the benefits, in which benefits should always prevail. So, this balance is assumed as something positive. The machinery will replace the workers only when it puts the health of the worker in danger. As previously mentioned, the learning process should attend the practical-theoretical questions, as well as the new career moment.

This study proposes a human resources analysis between healthcare 4.0 and nursing. The unemployment rate on nursing can be considered a lower tendency, through the industry 4.0 point of view, especially regarding the way the professionals take care and welcome patients in different situations. Another relevant aspect on unemployment is not updating knowledge, adjusting practices, and searching for specific competencies. This is the prism to be approached on the present research, since it presents a stronger tendency to come true. In this process, the industry has its role as the responsible to deliver better information for the user of a new technology. The knowledge process is continuous and dynamic and it should allow periodic review and rethink. The maintenance of the better information delivery and the checking of the learning steps will enable to conduct a better kept of the quality standards, which will be presented as following.

According to the World Economic Forum report (2017-2018), Brazil stands in the 80<sup>th</sup> position based on the 12 pillars of the Global Competitiveness Index among the 137 economies. Brazil recovered 11 positions on this ranking. The recovery of this position was for the search for transparency and the fight against corruption in the country, after a number of the scandals that the media reported. These economic concerns are presented on the report and also show a slight improvement based on the innovation, on the industry collaboration, and the research <sup>(5)</sup>.

However, once compared to Latin America and Caribe, it is possible to observe that the Brazilian macroeconomic environment has some opportunities, because it comes in a lower score towards this region. On the other hand, the size of Brazil also establishes opportunities, since it is the biggest South American country. Considering this aspect, the cultural diversity and the creativity of the Brazilian people also allow innovative ideas and entrepreneurship.

Thus, the 12 pillars were set by the World Economic Forum (2017-2018). These pillars are analyzed on the Brazilian scenario and showed that the Brazilian health and primary education have the second better index <sup>(5)</sup>. A trend graph points to a slight growth of this pillar. The Brazilian outlook, related to the transition of the fourth industrial revolution, specifically dealing with health-related issues, motivated the authors to answer the following questions: What are the opportunities for the nurses created by the healthcare 4.0? How can the nurses insert the healthcare 4.0 in their processes?

The method section presents aspects regarding the development of the study and the three topics to be developed by targeting the six pillars presented on the figure 1.

## **Method**

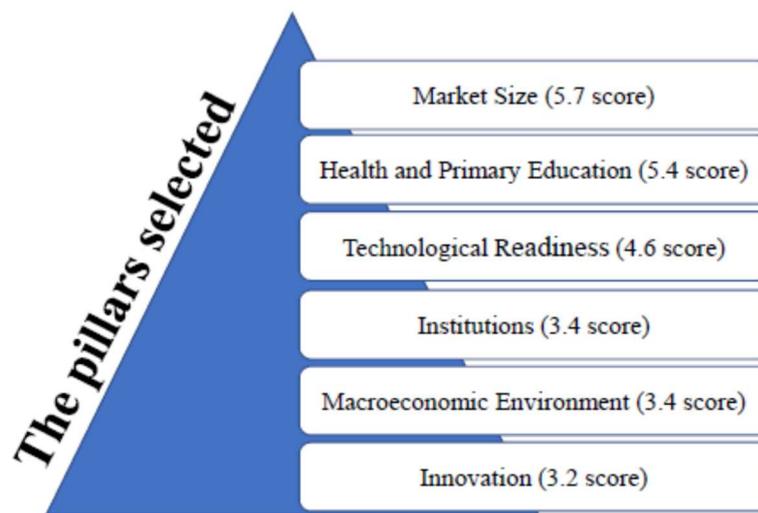
The researchers developed this study from May to November 2018. It presents as the main goal to analyze the insertion of the nurses in the fourth industrial revolution in Brazil, named here healthcare 4.0. In the context apprehended, Brazil still has its lacks on the insertion of the industry 4.0 and these lacks must be filled in. This perception can be evaluated through the index of the World Economic Forum report (2017 – 2018).

The research developed in 2016 shows that there is a huge lack between the traditional industry and the industry 4.0, with the identification of the different levels of the technological intelligence. This point reinforces that the future of the current industry is developing now towards the industry 4.0 <sup>(3)</sup>.

Then, for the analyses made for this study, the authors used this report and aimed to identify the aspects related to the 12 pillars of the Global Competitiveness Index. The World Economic Forum is an International Organization for the public-private collaboration. Aiming to give the guidance, to inform future - oriented solutions, and to provide orientation to policymakers, The Global Competitiveness Index establishes a combination of 114 indicators grouped in 12 pillars <sup>(5)</sup>.

For each of the 12 pillars presented (the institutions, the infrastructure, the macroeconomic environment, the health and primary education, the higher education and training, the goods market efficiency, the labor market efficiency, the financial market development, the technological readiness, the market size, the business sophistication, and the innovation) the Global Competitiveness Index attributed a score that ranged from one to seven. Based on this score, the pillars with the higher and the lowest scores are presented on the figure 1.

Fig. 1 - The six pillars arranged in order of punctuation, considering the ties disposed as presented by the World Economic Forum (2017-2018)



The pillars that presented the lowest scores are: innovation (3.2 score), institutions (3.4 score), and macroeconomic environment (3.4 score) and the ones with the higher scores are: technological readiness (4.6 score), health and primary education (5.4 score), and market size (5.7 score). The figure 1 presents the six pillars arranged in order of punctuation, considering the ties disposed as presented by the World Economic Forum (2017-2018).

A survey was carried out from 2005 to 2016, regarding the scientific production, under the theme “intelligent manufacturing” and it pictured the increasing of the production. The authors consider the subject as a key for the future and its relevance for the progress of the modern industry and economy <sup>(4)</sup>. The outlook from a systematic literature review discusses specific points of the Brazilian scene, like: how some of the national industries understand the concept of the digital technologies and their incorporation <sup>(6)</sup>.

From the analysis of the 12 pillars and its scores, the authors of the present research study purpose an analysis the three topics concerning the healthcare 4.0 and the nursing: the nurse

interprofessional education, its practices and competencies, under the scope of the six selected pillars.

## **Results**

The results section presents the nurses interprofessional education, their practices, and their competencies. All these aspects are presented based in the healthcare 4.0. The first considers the interaction that the knowledge of the nurses with the other concepts carries to healthcare 4.0 and the interprofessional relationship. The second shows the new approach for the practices of the nurses in the digital area, and the third brings the skills of the nurses to remain in the market under the healthcare 4.0 lenses.

The Brazilian job market has been through constant changes for decades. Some jobs were absorbed from new perspectives, like systems analyst. Other ones disappeared, like nursing attendant. Everlasting jobs, like nurses, keep on standing on the Brazilian healthcare job market, on its many specific areas of the work. Many of the new jobs come to the market, especially concerning healthcare. This context conducts a reflection about the first aspect: the interprofessional education of the nurses in the healthcare 4.0.

The new jobs and the professional skills are connected to the digital world<sup>(7)</sup>. These demands give nurses the chance to get in contact with the latest innovations and technology availability. In this sense, the digital knowledge influence brings people<sup>(4)</sup> from different areas to healthcare, creating new possibilities for the nursing. This new perspective is translated by several looks inside the career of the nursing and its work environment.

The nursing experiences the movement for the search the knowledge and the specific skills. The introduction and the adaption these practices in the healthcare institution take the new possibilities for their carriers. One of them is the interaction among other professionals that can provide an interdisciplinary movement inside the healthcare institutions. The interaction proposes a level of work that involves the nurses, the engineers, the system analysts, and the administrators.

The authors of this study searched the papers with the terms “interdisciplinaridade,” “interdisciplinar,” “interdisciplinario,” and “interdisciplinary,” published in the Revista Latino Americana de Enfermagem from 1993 to 2017. A number of seven papers was found in this search and is possible to know the insertion of this interdisciplinary movement. The table 1 shows the papers, the authors, the year, the volume, and the issue.

Table 1: The papers found with the terms “interdisciplinaridade,” “interdisciplinar,” “interdisciplinario,” and “interdisciplinary,” published in the Revista Latino Americana de Enfermagem (1993 – 2017) (Rio de Janeiro, RJ, Brazil – May to November 2018)

Title	Authors	Year - Volume - Issue
Interdisciplinaridade na saúde pública: um campo em construção <sup>(8)</sup>	Gomes, Romeu; Deslandes, Suely Ferreira	1994 2 - 2
Avaliação dos conhecimentos teóricos dos diabéticos de um programa interdisciplinar <sup>(9)</sup>	Almeida, Henriqueta Galvanin Guidio de; Takahashi, Olga Chizue; Haddad, Maria do Carmo Lourenço; Guariente, Helena Dantas de Menezes; Oliveira, Maria Leocádia de	1995 3 - 2
Participación de la comunidad en la problemática de salud: un modelo interdisciplinario de investigación acción <sup>(10)</sup>	Hausberger, Margarita; Wacsman, Raquel	2000 8 - 1
O processo de trabalho da enfermagem em saúde coletiva e a interdisciplinaridade <sup>(11)</sup>	Rocha, Semiramis Melani Melo; Almeida, Maria Cecília Puntel de	2000 8 - 6
Interdisciplinaridade e saúde: estudo bibliográfico <sup>(12)</sup>	Vilela, Elaine Morelato; Mendes, Iranilde José Messias	2003 11 - 4
Programa interdisciplinar de internação domiciliar de Marília-SP: custos de recursos materiais consumidos <sup>(13)</sup>	Mesquita, Sandra Renata Albino Marques; Anselmi, Maria Luiza; Santos, Claudia Benedita dos; Hayashida, Miyeko	2005 13 - 4
A dor e o desafio da interdisciplinaridade no cuidado à criança <sup>(14)</sup>	Menossi, Maria José; Lima, Regina Aparecida Garcia de; Corrêa, Adriana Katia	2008 16 - 3

This movement presents a new perspective for the nursing in order to improve the knowledge and the interaction with other professionals who work in different areas. The healthcare 4.0 can offer the capacitation and the opportunities to take a way to implement and to adapt the practices

in the healthcare institution routine. At this moment, the second perception about the influence the healthcare 4.0 is the practices of the nursing. A study approaching the use of technology as a facilitator of the nursing job was published in 1996. The authors mention that, even for that time, with the upcoming of the year 2000, the nursing employees still used technological resources with no previous knowledge and with no reflection about the side effects of this technology on the nursing assistance <sup>(15)</sup>. In the current century, the nurses are constantly searching to adapt to the technologies, like the new surgical procedures. This search ranges equipment and techniques, as well as developing skills in order to perform the robotic surgeries, for example. This kind of surgery especially is present on the intensive training section. To handle a robot and to be able to use it on a real case must be possible after months of the simulator training. The same way the air force provides the simulators to their pilots, many hospitals have a space for similar features. The aim is that the surgeons feel secure to operate using these robots.

On an interdisciplinary team, specialist nurses are presented in the operation rooms and who have robotics as an area of the knowledge and full dedication. There are equipment, software, and an amount of professionals involved in the healthcare institutions activities and the routines. Therefore, these robots have to be in sterile conditions, so that the infection risk is minimized. This is another example that joins the three aspects (the interprofessional education, the practices, and the competencies), to be presented in this section, the hybrid room. The hybrid operating room has the imaging equipment allowing the performance of the minimally invasive surgeries. These rooms are more and more present in the Brazilian healthcare institutions and enable the minimally invasive surgeries. Thus, the surgical team needs the professional qualification in accordance with the equipment handled. This opportunity brings value not only to the job performed, but also to the company, due to its stronger insertion on the fourth industrial revolution <sup>(2-3)</sup>.

The insertion of the electronic medical records also brought the sense of the adaptation in the healthcare professional routine. Some of the Brazilian healthcare institutions chose to allow the employees access by the visual features and the specific codes. It restrains the access to authorized personal only, in a way to turn it into a safer place. The equipment automation is another example of a new condition that was put to practice for the healthcare professionals. The automation delivers benefits for the nursing and the healthcare institutions. The equipment can help to keep ergonomic practices in the healthcare institution environment, especially those who have a dynamic routine. This kind of the routine can be understood by the number of the

surgeries performed at the institution and by the number of the patients attended in an intensive care unit.

The nurses receive stimulus to develop competences and raise the bar of their skills to work in the healthcare 4.0. For every new circle, the adaptations have to be done on the professional and the personal scope. Brazil is receiving reinforcement and stimulus for a faster insertion on the fourth industrial revolution. The nurses will need to search for the skills in this new step and the proper way to adapt to it. The click of a button and the access to information bring the possibility to keep the patient connected with the advantage of solving many situations. To establish a faster and more precise diagnosis can also be an advantage brought by the fourth industrial revolution <sup>(2-3)</sup>. The integration of the software, the systems, and the people can lead to an increase of the productivity with the maintenance of the quality standards allowing practicality of the activities. It is important to observe the constant search for educational actions that might influence directly on the quality of the processes.

The possible integration between the software, the systems, and the professional lives brings a new point to attention. But still, the change of the paradigm is necessary, in order to carry a new adaptation and to create competencies for the technology use. The insert of the internet of things <sup>(16-17)</sup> by the fourth industrial revolution points to the healthcare institution widely integrated by the systems, the software, and the people. This integration enables the areas to establish communication among the patients, the professionals and the digital information <sup>(4)</sup>. Some other aspects to be considered are the just in time delivery and the safe data storage, Many communication systems interconnect the human activities <sup>(18)</sup>. Among the technologies, they highlight as more promising the Internet of Things (IoT), the Internet of Services (IoS), and the Internet of People (IoP) <sup>(18)</sup>.

The healthcare institution is stimulated to assume the corporate social responsibility (CSR) role. One of the possibilities is the offering of data processing skills for the professional entrance on the digital universe. In return, the institution does not raise the turnover and invests in the supporting workforce that is qualified for their specific needs. The offer involves not only the basic courses, but also the proper equipment handling. It involves the attention given to the proper working of the new tools and the instruments. The next section approach the results presented and the discussion the main topics in order to answer the research questions.

## **Discussion**

This section will approach the two research questions: What are the opportunities for the nurses created by the healthcare 4.0? How can the nurses insert the healthcare 4.0 in the healthcare processes? This topic discusses two strategic aspects in corporate and professional skills. The

first one, the fortification of the CSR practices <sup>(19-20)</sup>, in the healthcare institutions can be made through a variety of programs, including educational ones <sup>(21)</sup>. On the other hand, the industrial revolution presents the nurses need to build its career and to be prepared for the possible transitions. Sometimes, the input of the technologies throughout the years might have been silent for a part of these workers, so it did not wake them up for this new reality. For other ones, more attempted for the changes, the professional realignment was built in different speeds. It is a highlight, because the healthcare professionals are the agents of own change and the one responsible to transform its career. It takes the lead and takes own decisions to build their future. The continuous education process in nursing brings the knowledge improvement, the quality assistance, and the customer satisfaction. The technological tools enable a new culture and the technological advance in the nursing education. The e-learning is a one of the tools that represents the technological revolution.

The absorption of the technologies named as hard technologies in this case, by the Brazilian healthcare institutions, imposes this kind of behavior from the professional side. At the same time that the hospitals seek to offer the necessary conditions for the knowledge acquisition and the safe equipment handling, the professionals should seek for skills improvement. It could be noticed by means of the surgical environment observation, done by the authors, on their fields of work, consistent with the input and the integration of the equipment, the systems, the software, and the people.

The skill and the ability are two points that should be present, providing the agility and the accuracy to the process. Controlling problems and minimizing implied risks are daily evaluation points made by the surgical room management and the hemodynamic center. That is why the enrolment of the industry on skilling programs and the partnerships with the healthcare institutions are present in this process. At least the knowledge for the computer handling is demanded at the healthcare 4.0. But there are some relevant questions to be made at this point: Are all the nurses prepared for that? Are the nurses capable and do they feel able for this new stage? It is quite probable that many difficulties will be faced by the people who are not still adapted and ready to be inserted in this new stage of the work.

The nurses, with the insertion of these procedures, search a higher interaction with the equipment and the new techniques. It can become simpler by the approach with daily tools like the apps, the interactive games, and all the ways opened by the Internet of Things <sup>(22)</sup>. A new perspective comes up for these professionals, who should understand this scenario as an opportunity to overcome any difficulty they might find out on their way.

The “trends and expected developments for the value creation factors”<sup>(23)</sup> and establish that the industry 4.0 brings the application of the automatized tools and the robots. The authors exemplify the co-working of the robots and the employees (equipment). In order to do so, the workers take part on alignment and decision making, but they have to be capacitated for that. When the employees have more knowledge, they start to monitor the equipment (human). They establish that the increase on manufacture complexity will be present. The workers and the artificial intelligence will make the decision (organization). The increase on the value creation process will be driven by the disruptive technologies of the industry 4.0 (process) and the customized products (product).

The robot is a partnership during the security care procedures and the number of the robots improves, but in the nursing care this entrance is low at this moment<sup>(24)</sup>. The opportunity brings the industry 4.0<sup>(25)</sup> to improve the professional level and allow new ways to adapt everyday situations into a new routine. An innovation process turns into a new routine for those who are already a part of the healthcare job market, as well as for the nurse skills to come, in order to optimize the healthcare processes. This innovation movement creates a range of the possibilities to capacitate and to update professionals who are already a part of the market, inserting them on the digital world<sup>(18)</sup>.

The capacitation programs offered by the companies that are inserting the industry 4.0 into their routines enable specialized and skilled professionals. The internet of things operation is part of this process and the advances given by this transformation should have their place previously defined. The insertion of the individuals who learn new skills and who transform the skills they have should be a goal. The automation will need men and women who are able to operate the machinery and who have the autonomy for the decision making.

The interprofessional education is a potential to reinforce the healthcare system. The authors show the approach with Pan-American of Health Organization/ World Health Organization and show that the professionals should be inter-professionals<sup>(26)</sup>.

The subject interprofessional education is presented as a promising strategy in which professionals learn from each other, with the possibility of improvement on assistance and the mitigation of the crisis on the healthcare field of action as a result. The authors of the study inform the release of the Healthcare Interprofessional Educational Regional Networking, which counts on the participation of the American countries, being supervised by Argentina, Brazil, and Chile<sup>(27)</sup>. The connection of the knowledge promoted by the interprofessionalization presents great innovations in terms of the competence along the century.

The hybrid room, the electronic medical records, the traceable systems, and the electronic automation are parts of the healthcare 4.0. Therefore, to be connected to new concepts is a matter of survival for this job market. The attributions of the nurses include the human resources and the team work management. The internet can be used in a lot of situations and is a part of the changes in the nursing routine. The use of the internet is discussed on a paper that approaches the basic healthcare system in Ribeirão Preto <sup>(28)</sup>. The authors refer to the quickness on obtaining data, as well as its precision and security as the two most relevant aspects regarding the aims of the technology use on healthcare institutions that participated of the study. This paper was published 22 years ago and if a parallel is made between it and the year 2018, other aims could be met, but both quickness on obtaining data and security are much discussed topics still nowadays, concerning the healthcare professionals lives.

The concern about the unemployment is real and should be discussed in the healthcare institutions. This discussion should be conducted with management models that stimulate and put the professional in this scenario. The unemployment is discussed under the scenario of the fourth industrial revolution, at the same time it creates an opposition towards what is presented as an opportunity for professional innovation.

The possibility of the unemployment will always exist, but it is more likely to happen for those who do not search for the proper skilling and recycling knowledge <sup>(29)</sup> in a specific area.

It leads to new activities, to the search of the working spaces, and to the professional relocation in different markets. Therefore, the fear of losing a job position for a machine becomes a possibility and brings a change of attitudes, which include the adoption of the educational measures, so that man can control the machine. The figure 3 shows the highlights the promotion of the professional innovation purposes by the healthcare 4.0.

The healthcare and nursing are connected in the top of the figure. The three dimensions are positioned in the center of the figure 3. Beside of them, there are the healthcare institution. It is represented by the corporate social responsibility, the innovation of the technologies, and the promotion of the quality. The other side are the professionals like transformation agent, with ability, skills, competence, knowledge, and professional training.

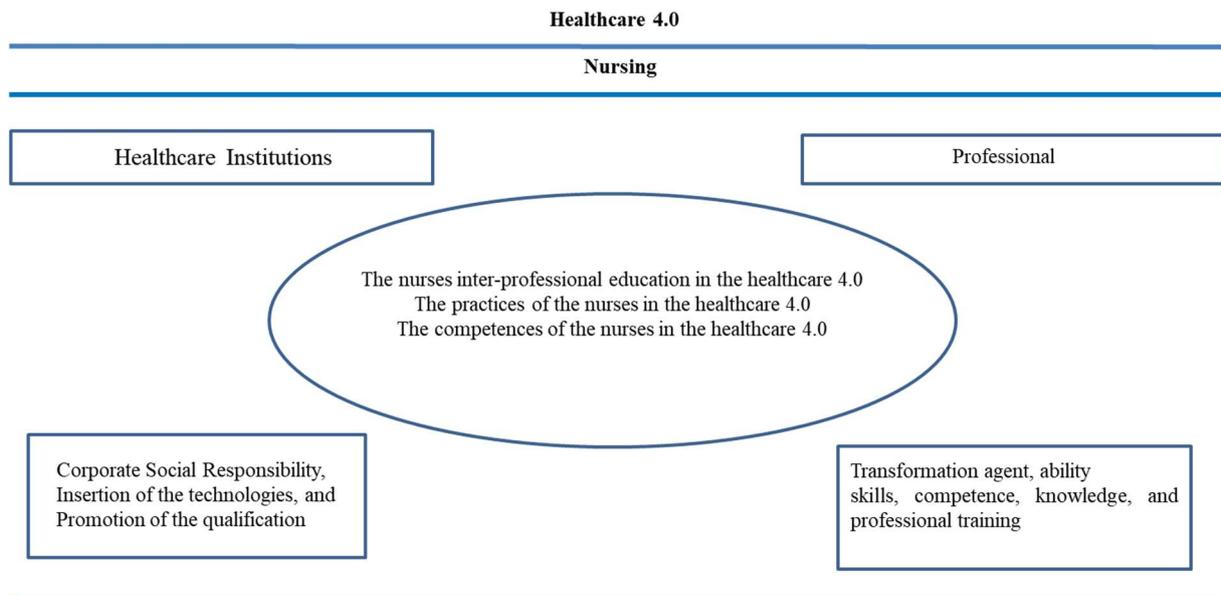


Fig. 3: The promotion of the professional innovation purposes by the healthcare 4.0

### Conclusion

The fourth industrial revolution defines a new period for the society. The insertion of the healthcare 4.0 in Brazil has been constantly discussed, as well as in which stage the country is set. The geographic length of the Brazilian territory and the cultural diversity are challenging points of this path. The present study aimed to analyze the insertion of the nurses in this fourth stage, focusing in the healthcare 4.0. The research had the World Economic Forum report (2017-2018) as basis for the present analysis, through the Global Competitiveness Index document. For this purpose, six of the 12 pillars presented on this report were selected. The higher and the lower scores were grouped. From this organization, the healthcare 4.0 was discussed under the three aspects established for the interprofessional education, the practices, and the competencies.

The same way, these health institutions may maintain the CSR stimulating the professional innovation. In this sense, the institution and the nurses assume a central position and create many possibilities. These are connected not only by the professional capacitation offered by the institution, but also by the proactivity of the nurses in becoming its own transformation agent. The interprofessional education, the practices, and the competencies can be the way for interaction between nurses and healthcare 4.0.

New studies should be stimulated with approaches in other Brazilian sectors. The stimulus to this kind of study creates a way to call attention of the people for the need of basic development and the reach of other levels on this migration baseline. The present study has limitations, which

are, base material that supports the theme, but the relevance of the future researches cannot be forgotten.

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