

# The contribution of logistics to the strengthening of national production and universal access in the scope of the Unified Health System

*A contribuição da logística para o fortalecimento da produção nacional e para o acesso universal no âmbito do SUS*

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**ABSTRACT** The objective was to point out the essential elements of logistics that contribute to the promotion of access in the context of the health production system to articulate national production, reduce external dependence to enable universal access and the strengthening of the Unified Health System (SUS) in the context of the pandemic and health crisis. Qualitative bibliographic-based research was used as a methodological strategy on the concepts of health system, public health, access to medicines, added to the profile of national logistics operators and the operationalization of the Ministry of Health's national immunization plan against COVID-19. It was concluded that logistics plays a fundamental role in promoting access to health technologies and it is necessary to undertake research efforts that include the actors of the productive sector capable of contributing to the elaboration of public policies in the field of health. The central elements of logistics need to be highlighted in order to strengthen an agenda that articulates the Health Economic-Industrial Complex with universal access, considering logistical factors as critical elements without which access does not materialize. Logistical systems should be thought of as a resource of universal health systems to enable their integrality and sustainability.

**KEYWORDS** Health Economic-Industrial Complex. Economic development. Unified Health System. Logistics. Pharmaceuticals.

**RESUMO** Objetivou-se apontar os elementos essenciais da logística que contribuem para a promoção do acesso no contexto do sistema produtivo da saúde, visando articular a produção nacional, reduzir a dependência externa para viabilizar o acesso universal e o fortalecimento do Sistema Único de Saúde (SUS) em um contexto de pandemia e crise sanitária. Utilizou-se como estratégia metodológica uma pesquisa qualitativa de base bibliográfica sobre os conceitos de sistemas de saúde, saúde pública e acesso a medicamentos e vacinas, somados ao perfil dos operadores logísticos nacionais e à operacionalização do plano nacional de imunização contra a Covid-19 do Ministério da Saúde. Concluiu-se que a logística desempenha papel fundamental na promoção do acesso às tecnologias em saúde, sendo necessário empreender esforços em pesquisas que incluam os atores do setor produtivo capazes de contribuir com a elaboração de políticas públicas na área da saúde. Os elementos centrais da logística precisam ser ressaltados para o fortalecimento de uma agenda que articule o Complexo Econômico-Industrial da Saúde com o acesso universal, pensando nos fatores logísticos como elementos críticos sem os quais o acesso não se materializa. É necessário que os sistemas logísticos sejam pensados como recurso dos sistemas de saúde para viabilizar sua integralidade e sustentabilidade.

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**PALAVRAS-CHAVE** Complexo Econômico-Industrial da Saúde. Desenvolvimento econômico. Sistema Único de Saúde. Logística. Medicamentos.



## Introduction

When thinking about a universal health system, it is necessary to consider all social, political, and economic actors that can contribute to its sustainability, and logistics has become a central issue for health systems regarding the guarantee of access to their technologies, gaining even more relevance in the period of pandemic. Until then, it had been treated more as an engineering resource and less as an essential element for health policies when discussing with technical areas.

Logistics has even been neglected in the Health Economic-Industrial Complex (HEIC), which is dedicated to the articulation between technological advancement, productive development, and health promotion, and which reinforces the need for the participation of several areas of science for its strengthening.<sup>1</sup> Despite its importance for the productive health system, we do not see the participation of logistics in the formulation of health policies, despite its potential to contribute to strengthen the HEIC by supplying the industries that make up its subsystems and the movement of production through the territories, from the most developed to the most needy, contributing to a comprehensive effectiveness of access.

From the perspective of health systems<sup>2</sup>, and in the scenario of the new coronavirus pandemic, logistics plays a fundamental role in the safe transportation of vaccines to preserve their characteristics and make them reach the population through the Brazilian immunization strategy. Another key role is to avoid interrupting supply chains at a time when the national production system needs to be strengthened to reduce external dependence on strategic health items in the face of COVID-19.

This work aims to deepen the importance of logistics for health policies and for the COVID-19 immunization strategy adopted in Brazil with regard to the operationalization of the Brazilian government's vaccination plan by the Unified Health System (SUS), from the

acquisition of vaccines to the distribution throughout the national territory, with the challenge of maintaining its efficacy and safety during all phases of the distribution chain, aiming to immunize the entire population, regardless of the region of the country. In addition, it is aimed at contributing to the debate on access and the need to strengthen the internal production of materials and strategic products for health and reducing external dependence and economic development addressed by HEIC, reinforcing the understanding that health and economic development are not in opposite fields<sup>3</sup>.

The study was carried out through qualitative bibliographic-based research that sought to address the literature on health and public health systems that establish a dialogue with economic development and the scenario of the health crisis of the SARS-CoV-2 pandemic (COVID-19). The scientific database SciELO was used because it includes a wide range of articles related to health. The following descriptors were searched for: 'health system, health economic-industrial complex, public health, public health, determinants in health, economy and health, pharmaceutical industry, medicines, vaccines, and immunization'. Searches were also made in non-specific health databases, to access references that have a dialogue with health to carry out the discussion of the article, such as: 'supply chain, economic development, business logistics, logistics operators, pharmaceutical industry, production systems'. We found 425 references among articles, books, book chapters, theses, dissertations, technical notes, websites and legislation, 48 of which were selected because they contain topics related to the objective of the study.

The last survey carried out by the Brazilian Association of Logistics Operators (Abol) with technical-academic support from the Dom Cabral Foundation (FDC), in 2020, on the profile of national logistics operators was analyzed. Then, the national immunization plan of the Ministry of Health (MH) was analyzed to identify the logistical challenges of

starting vaccinating the entire population at the same time, the specifications of quality of the vaccines that were authorized by the National Health Surveillance Agency (Anvisa) to be used in Brazil and the health legislation in force in the country related to good manufacturing practices, storage and transport/distribution of Critical Inputs (API), followed by discussions and conclusions.

## The participation of logistics in technological revolutions and development

The history of the industrial development in the world was marked by revolutions that transformed the technologies then employed<sup>4</sup>. The First Industrial Revolution, which took place in the second half of the eighteenth century, had artisanal labor replaced by wage labor in factories, establishing the first paradigm of production: large-scale production. This revolution was marked by the introduction of machines into the production process and the manufacture of chemicals. During this period, there was the first major change in logistics, with the expansion of transportation through the growth of the construction industry driven by steel production, resulting in an increase of populations in large industrial centers, which motivated the movement of products and people on a larger scale.

At that time, the great logistical challenge was the distribution of products that did not have an adequate means of transport for the disposal of their production, which began to happen in greater volumes with the development of industries, in addition to the triangular trade between Europe, Africa, and the Americas, with the export of weapons, textiles and beverages in exchange for slave labor to feed the production of sugar, tobacco, and cotton that took place between the continents.

The Second Industrial Revolution<sup>5</sup>, in the nineteenth century, the so-called century of science, had as its great milestone the development of the chemical, electrical, and oil industries, together with the evolution of the means of transport and communication. Then, the second major transformation in logistics operations took place, enhanced by the inventions of the period, such as the airplane, electricity, mechanical refrigeration, and the telephone, together with innovations in the production lines that gave rise to mass production, in addition to shedding light to the importance of logistics with the expansion of the road network and the transport of loads by trucks, which enabled the distribution of industrialized products on a larger scale. Logistics was still limited to transportation and distribution, but without it, production would not reach the points of sale and consumption.

The Third Industrial Revolution was marked by the creation of the internet, which replaced analog with digital technology, the use of microcomputers, which provided the growth of file digitization<sup>6</sup>.

In addition to these great innovations, during this period, mobile phones were invented, which ended up being the great inspiration for the next revolution. With this, logistics becomes once and for all the protagonist of production processes, and logistics operators reinforce the role of logistics as an extension of the industry.

With globalization, production gains specific characteristics to meet product quality requirements, innovation becomes a necessity, and logistics planning activities are introduced into the concept of logistics management, which, in turn, leaves the transport/distribution area and starts to involve a broader process, ranging from the acquisition of raw materials, inventory management, production management, demand management to the control of operations, which include storage, quality, distribution, and transportation activities.

Health begins to show its participation in economic development, with the production

of several innovative medicines and with the advancement of medicine, in addition to the development of genetic engineering and biotechnology in the area of science.

The creation of the internet and the invention of the mobile phone were the main ingredients for the transition from the third and fourth technological revolutions, maintaining the characteristics of disruption common to

revolutions<sup>7</sup>. These innovations enhanced the advent of digitization, mobility, and speed of information, allowing for the use of the various technologies available in the generation of knowledge and productivity that characterize the concept of the industry 4.0, and can be seen as a natural development of previous revolutions.

Table 1. The evolution of the participation of logistics in economic development

Historical Event	Period	Technologies	Paradigm	Logistics Participation
The 1st Industrial Revolution	18th century	Steam engine; Metallurgy; Mining; Transport and Infrastructure	Mass Production: Replacement of Artisanal Labor by Wage Labor	Triangular trade exports between the European, African and American continents and movement of products and people
2nd Industrial Revolution	19th century	Technological development; Advancement of means of transport; Invention of means of communication; Organizational Innovations	Technical and work regulation: institution of the semi-automatic assembly line in the production lines and separation of manual and intellectual labor	Outflow of production with the larger scale distribution of industrialized products by means of trucks
3rd Industrial Revolution	20th century	Digital technology (Internet); Mobile Phone; Robotics; Electronics; Softwares; Mobile devices	Digital transformation: knowledge in the form of information	Logistics operators acting as an extension of the industry offering logistics solutions
4th Industrial Revolution	21st century	Internet of Things; Artificial Intelligence; Big Data; Automation; Nanotechnology; Connectivity; 3D Printing; Augmented Reality	Interconnectivity between knowledge and information. Increased efficiency through cyber-physical resources	Logistics 4.0 promotes increased productivity and competitiveness through technological integration between supply chain actors

Source: Prepared by the authors.

Table 1 shows the participation of logistics in technological revolutions over time and how it contributes to development, showing that, without the participation of logistics, production does not become accessible and is restricted to manufacturing areas, blocking the development process.

The productive sector of all segments of the economy has always relied on logistics to make its production reach the points of consumption, and health is not an exception. All inputs, materials, and products used in

the generation of new technologies involve some logistics activity, if not all of them. In this pandemic scenario, where several locomotion restrictions are necessary to preserve social distancing as a way to control contamination, logistics plays a key role.

In the productive dynamics, goods and services are moved from one place to the other; and. Until they reach the end of the chain, it is necessary to add value in the various forms of movement, respecting the deadlines and the needs of users<sup>8</sup>. The

movement of goods and services is a concern of the operational management of logistics that comprises the initial shipment, regardless of where they are, until the destination<sup>9</sup>, when the objective of the industry is effective because the entire effort of production in the generation of technologies will be of no use if they cannot reach those who need them. It is from this perspective that logistics is an essential element for health systems, allowing the continuity of the production of technologies and the effective access to them.

## **The Unified Health System and the confrontation of the pandemic of the new coronavirus**

In addition to the challenges common to health systems, there are others that need specific actions. The most recent one has global consequences and has put health systems worldwide to the test is the SARS-CoV-2 (COVID-19) pandemic. Even in countries where health systems have a better structure to effectively promote a welfare state, the challenges have been great and have required from governments additional efforts.

When the first vaccines developed by the pharmaceutical industry became available, a new challenge arose. The logistical challenge of making the vaccine reach the entire population, regardless of where they are, becomes even more difficult in countries of large territorial dimensions and social inequalities such as Brazil.

The resilience of health systems is analyzed when their performance is affected by economic and health crises<sup>10-12</sup>. The SUS had its resilience tested when the ability to respond to the population's health needs was impacted by the pandemic that shook the national logistics system, disrupting the supply chains of strategic health supplies and challenging both medical-hospital care services

and the production of vaccines, to which the SUS proved to be able to provide the necessary responses even in times of crisis.

Health systems are composed of several actors whose activities are directly or indirectly related to the provision of healthcare<sup>2,13</sup>. This concept reinforces the multidisciplinary profile of collective health that goes beyond those specific fields directly related to health, encompassing others that also contribute through their determinants, including the economic ones<sup>14,15</sup>, with regard to the provision of health services, which need to act in an integrated manner for the success of universal systems.

The products (goods and services) that health systems offer need to reach all users equally, and the main challenge is to prevent people who have fewer resources from having less access to health technologies in the quantity and quality they need to achieve Social Welfare State necessary to provide them with a dignified life<sup>16</sup>. In this sense, when shaping health systems, the integration between actors, agents, values, ideals, interests, projects, and strategies needs to be prioritized taking into account political, economic, social, and institutional aspects, considering their main components and their management functions<sup>2</sup>.

Through a well-structured health system, we seek to reduce social disparities by offering goods and services that cannot be accessed through work or lack of it<sup>17</sup>. Social policies have economic impacts, since, by minimizing social risks, economic stabilization is promoted by reducing uncertainties in consumption cycles, which contributes to a scenario of stability<sup>18</sup>.

The SUS is part of the Federal Constitution, which is seen as a Citizen Constitution<sup>19,20</sup>, contemplating economic, technological, industrial, and social policies<sup>21</sup> to guarantee its sustainability, uniting the social and economic dimensions for the social protection of the population. In addition, SUS has a set of actions<sup>22,23</sup> that contribute to the principle of

integrality<sup>24</sup> and is supported by a HEIC<sup>25-30</sup> that brings together a dynamic focused on the sustainability of the system and contributes to social protection actions that depend on the organization and operation of the productive dynamics of goods and services in health and effective access to them, in which logistics has fundamental participation.

In Asia, the first region affected by the disease, the experience with previous epidemics has allowed the governments of that continent to give quick and efficient responses through public health policies, such as mass testing and isolation of those infected, as well as economic measures, such as financial support to vulnerable groups, and measures such as changes in the behavior of the population. In Europe, there were different responses, but all went through the structure of health systems in countries such as Germany, Italy, Spain, and the United Kingdom, where hospital capacity, including specialized beds, mass testing, social isolation measures to prevent spreading the virus among the community and the existence of effective Social Welfare systems helped reduce the consequences of the pandemic.

The American continent was the region where the population suffered with the highest number of contamination and deaths as a result of the delay of the authorities in taking measures to prevent the entry and spread of the virus. Many people in poverty, the fragility of health systems, and a low-responsive social welfare system have contributed to weaknesses that have resulted in a higher number of infections and deaths than in other countries<sup>31-35</sup>.

Two years after the official confirmation of the first case of COVID-19 in Brazil, it is possible to better observe the actions and strategies carried out by the country to combat the disease. After the initial phase, where the strategies to combat the disease were basically aimed at avoiding the circulation of the virus in the community and at treating those already infected in the hospital network,

while the pharmaceutical industry sought to discover a vaccine, the country already has some vaccines for its immunization strategy.

In this new phase, the Brazilian health system needs to count on an efficient logistics system to preserve the integrity of vaccines, in order to avoid losses and degradation of products throughout the distribution chain. According to the World Health Organization (WHO)<sup>36</sup>, about 25% of all vaccines produced in the world are wasted before reaching citizens, and up to 50% may be ineffective due to storage problems or other logistical issues that impact the financial, material, and human resources involved in vaccine research, development, and manufacturing, as well as the number of people who no longer have access to vaccines that are lost. In this context, logistics is an important resource of the health system for its ability to strategically position vaccine stocks and take them safely to immunization places.

## **National logistics operators and the Brazilian logistics system**

The conformation of the logistics systems of the countries demonstrates the organization of local economies and the degree of competitiveness in relation to the global economy. Logistics is a sector that grows year by year, which shows its ability to act in times of crisis, serving all essential sectors of the economy, from the main urban industrial centers to the most distant territories of the country. Traditionally, the logistics systems have acted as a competitive resource for companies and nations through the optimization of operating costs and the movement of production, with added value until its delivery to final consumption, contributing to the non-interruption of production chains.

The incorporation of technologies such as cargo tracking, technological integration

with customers, integrated planning technologies between sales and operations and technologies for order processing by the sector demonstrate an alignment with the paradigm of the fourth technological revolution and with the initiatives globally implemented in logistics operations with a focus on technological integration of supply chains. However, all this expertise needs to be explored in the elaboration of economic development policies, and this has not happened, causing the logistics sector to act in isolation and focus its investments to retail and e-commerce<sup>37</sup>.

At a time of health crisis, when economies worldwide have shown their fragility with the external dependence on strategic items to combat the pandemic, it is important to unite the segments of the industry that have the potential to change this scenario and contribute to the strengthening of local production. However, according to recent research carried out by Abol and FDC<sup>37</sup>, the market of logistics operators in the country does not perceive the external dependence of the national industry on strategic items for local production as one of the factors that stand out as obstacles or challenges for national logistics operations, even though the human health segment (pharmaceuticals and medicines) is the second largest market of logistics operators.

This scenario draws attention to the necessity of improving the vision of national logistics operators to strengthen the issues

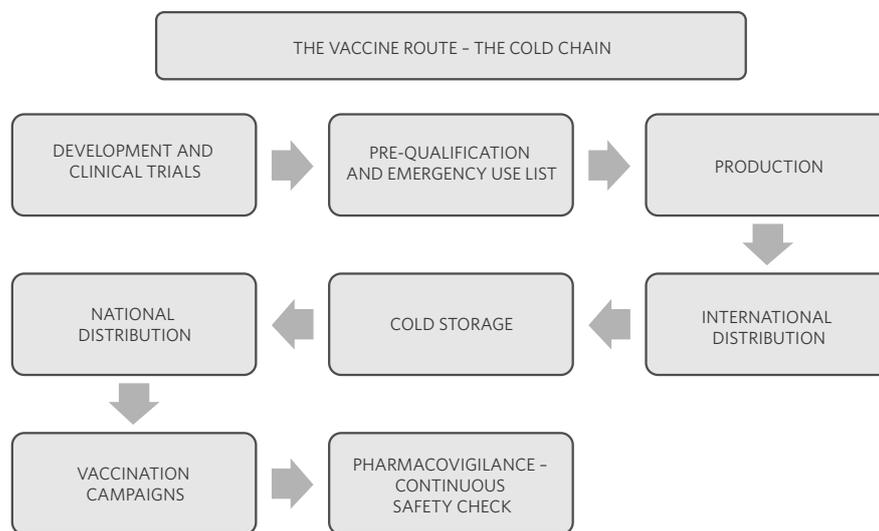
related to the health sector with regard to the contribution they can make to the reorientation of domestic production.

## Pharmaceutical logistics in the vaccine segment

In addition to highlighting the importance of logistics to overcome the crisis of the distribution chain of strategic inputs used in the production of items that meet the demands of various segments of the economy, the pandemic of the new coronavirus exposes the importance of the logistics branch that serves an important segment of the productive sector: health.

In the specific case of COVID-19 vaccines, the logistics operation gains even more prominence due to the complexity involved in this operation because they are health technologies that were produced in a much shorter time than the usual one, a situation that imposes a greater challenge to pharmacovigilance actions in the case of eventual failures in the distribution logistics chain that can impact effectiveness and safety, resulting in adverse reactions that make it difficult to identify the root cause and raise doubts about the research and development process<sup>38</sup>. The vaccine route, from its development to delivery to be injected, is full of technological complexity that involves a cold chain in which logistics has an important participation, as illustrated in *figure 1*<sup>38</sup>.

Figure 1. The cold chain in vaccine development and distribution



Source: Prepared by the authors based on WHO<sup>38</sup>.

The pharmaceutical industry, as part of the health sector, is served by a branch of logistics responsible for responding to the challenges of moving products of high technical and technological complexity, such as pharmaceutical inputs, medicines, and vaccines that need particular care to preserve their quality, efficacy, and safety. This is pharmaceutical logistics, which has gained

prominence in the economy because vaccines are a strategic market segment of the pharmaceutical industry<sup>1</sup>. A framework of laws, regulatory standards, and resolutions aimed at good manufacturing, warehousing, and distribution/transportation practices guides pharmaceutical logistics. *Table 2* presents the main legislation of this legal framework and its relationship with logistical activities.

Table 2. Main health legislation for pharmaceutical logistics activities

Legal framework	Issuing Agency/ Office	Purpose	Target audience	Relationship between logistics, the health sector, and the pharmaceutical market
Law No. 5,991, December 17, 1973	Ministry of Health	Sanitary Control of Trade in Pharmaceuticals, Medicines, Pharmaceutical Inputs	Pharmaceutical Industries, Pharmochemical Industries	Regulates economic activity in the health sector
Law No. 6,360, September 23, 1976	Ministry of Health	Health Surveillance of Medicines, Pharmaceuticals, Pharmaceutical Inputs	Pharmaceutical Industries, Pharmochemical Industries	Regulates the performance of the productive sector for manufacturing safety
Ordinance No. 802, October 8, 1998	Ministry of Health	Sanitary control and supervision of the production, distribution, transport, and storage chain of pharmaceutical products	Members of the production chain of pharmaceuticals	Regulates the pharmaceutical manufacturing supply chain
Ordinance No. 1.052, December 29, 1998	Ministry of Health	Operating Authorization for companies transporting pharmaceuticals and pharmacochemicals	Logistics Operators and Drug Transport Companies	Regulates the participation in the health sector of companies that operate in the transport activity

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Legal framework	Issuing Agency/ Office	Purpose	Target audience	Relationship between logistics, the health sector, and the pharmaceutical market
Resolution No. 329, July 22, 1999	Brazilian Health Surveillance Agency	Inspection Roadmap for Medicines, Pharmaceuticals and Pharmaceutical Input Carriers	Logistics Operators and Pharmaceutical Transport Companies	Regulates the participation in the health sector of companies that operate in transportation
Resolution No. 363, October 2, 2001	Federal Council of Pharmacy	Regulates the activities of the pharmacist, in the storage of products in ports, airports, borders, and customs	Pharmaceutical professionals and warehousing companies	Controls professional category and storage activity in the import of critical inputs for health
Resolution No. 433, April 26, 2005	Federal Council of Pharmacy	Regulates the performance of the pharmacist in a land, air, rail or river transport company, of pharmaceuticals, pharmacochemicals	Pharmaceutical professionals and transport companies	Achieves the multimodality of transport activity for action in the health sector
Law No. 11.903, January 14, 2009	Presidency of Brazil	Tracking pharmaceutical production and consumption through electronic data capture and transmission technology	Supply chain of medicines	Logistics 4.0 interconnectivity of the logistics chain for data digitization
RDC No. 54, December 10, 2013	Brazilian Health Surveillance Agency	Implementation of the national drug control system to track the pharmaceutical chain	Supply chain of medicines	Logistics 4.0 in meeting the requirements of the national pharmaceutical control system
Law No. 13.410, December 28, 2016	Presidency of Brazil	Amends some articles of Law No. 11.903 to provide for the National Pharmaceutical Control System	Supply chain of medicines	Logistics 4.0 in meeting the requirements of the national pharmaceutical control system
RDC No. 157, May 11, 2017	Brazilian Health Surveillance Agency	Implementation of the National Pharmaceutical Control System	Pharmaceutical Industries and other members of pharmaceutical production chain	Assigns responsibilities to all members of the pharmaceutical production chain
Normative Instruction No. 19, August 22, 2017	Brazilian Health Surveillance Agency	Basic Technology Definitions for Pharmaceutical Chain Communication	Pharmaceutical Industries and other members of pharmaceutical production chain	Logistics 4.0 in meeting the requirements of the pharmaceutical distribution chain
RDC No. 234, June 20, 2018	Brazilian Health Surveillance Agency	Outsourcing of production steps, quality control, and logistics of medicines and biological products	Pharmaceutical Industries and other companies operating in the drug production chain	Guides the pharmaceutical production chain and transport and storage activities
RDC No. 304, September 17th, 2019	Brazilian Health Surveillance Agency	Good Practices for Distribution, Storage, and Transport of Medicines	Logistics Operators	Guides the entire pharmaceutical logistics operation
Resolution No. 679, November 21, 2019	Federal Council of Pharmacy	Tasks of the pharmacist in foreign trade and multimodality of the transport of medicines and pharmaceutical supplies	Professional category of pharmacists	Guides professional category of pharmaceutical logistics
RDC No. 360, March 27, 2020	Brazilian Health Surveillance Agency	Good Practices for Distribution, Storage, and Transport of Medicines	Logistics Operators working in the health sector	Guides members of the pharmaceutical distribution chain regarding transportation
RDC No. 430, October 8, 2020	Brazilian Health Surveillance Agency	Provides for Good Practices for the Distribution, Storage, and Transport of Medicines	Logistics Operators working in the health sector	Guides the logistics operation. Relates to Logistics 4.0 technologies
RDC No. 658, March 30, 2022	Brazilian Health Surveillance Agency	Provides for the General Guidelines for Good Manufacturing Practices for Medicines	Pharmaceutical and pharmaceutical industries and other members of the production chain	Establishes guidelines for the entire pharmaceuticals manufacturing production chain

Source: Prepared by the authors.

Over time, this legal framework has included specific nomenclatures and expressions of logistics operations in its documents, evidencing the protagonism of this activity in the health sector. Among the primary and support activities of the business logistics, there are transportation, inventory maintenance, order processing, storage, protective packaging, acquisitions, information maintenance, among others<sup>8,9</sup>. These have been incorporated into laws and sanitary resolutions. Controls related to storage and transportation are the most used ones, but others, such as protective packaging, acquisitions, and maintenance of information, also appear in this legal framework, consolidating pharmaceutical logistics as a branch of logistics that has a relevant role in health. It is through this relationship between health legislation and logistics activities that the definition of pharmaceutical logistics is established.

When talking about vaccines and medicines, it is important to highlight that, in addition to price, which is one of the barriers to access, problems related to logistical issues are also among the weaknesses in the provision of this health technology by SUS<sup>39</sup>. Considering the participation of pharmaceutical logistics in the set of elements that guarantee access in adequate quantity and quality<sup>39</sup> and its participation in the phases of Research, Development (R&D), and production, it is possible to think of a way to negotiate the reduction in the final prices of products with industries despite the power of the pharmaceutical industry. This can be accomplished in the field of public policies and management and in the control of logistics activities, improving the service levels of manufacturing processes, aiming to reduce production costs that, as well as those of R&D, are charged in the final prices of products<sup>40</sup>. Logistics is an important component of the spending structure and needs to be considered as a way to reduce the costs of offering health technologies.

## The operationalization of COVID-19 vaccination in Brazil

The National Immunization Program (PNI)<sup>22</sup> is a public policy in the field of health prevention that marks the history of Brazilian immunization policy and aims to coordinate immunization actions in the country through the capacity that a mass vaccination policy has to eradicate diseases. Since its creation, the PNI has been a space to develop technologies and improve the methodology of large vaccination campaigns seen as a strategy that has always been present as an instrument for disease control and that is still used in the development of public policies for health with great acceptance by the population, making Brazil gain the respect of countries with a smaller population and better social and economic conditions<sup>41</sup>.

Considered one of the largest vaccination programs in the world, recognized nationally and internationally, and with more than 47 years of expertise in mass vaccination, the PNI assumed the responsibility of promoting vaccination against the new coronavirus in the country<sup>42</sup>.

COVID-19 is the largest pandemic in the recent history of humanity, and several pharmaceutical industries around the world carry out research and developments seeking to produce safe and effective vaccines against the disease. Some are already being released for emergency use and/or definitively registered in some countries, when there is a large monitoring action by pharmacovigilance systems and adverse events that may have the root cause in any of the stages of vaccine manufacture, in which storage and transportation are included.

Among the measures adopted in Brazil to combat the pandemic is the creation of an immunization plan<sup>42</sup> that involved the negotiation of commercial and political agreements for the acquisition of vaccines from

manufacturers, in addition to production in the country, through technology transfer agreements for those who have already received authorization for emergency or definitive use.

With regard to operationalization, the plan addresses the logistics already involved in the population immunization strategy, which is a great challenge, considering the Brazilian climatic characteristics, different from other climatic zones in the world, with territorial dimensions that impose additional controls and care, both in preserving the efficacy and safety of vaccines and in giving access to them to the entire population.

Immunization of the population is an action not only to combat the disease, but also to restore normality, which will allow the resumption of the economy and development of the country. As well as the other events that led to the development throughout history, in this challenge, logistics also has an important participation with its activities and controls.

To date, four COVID-19 vaccines are authorized for use in Brazil, and, due to their characteristics, it is necessary to have a cold chain that meets the technical specifications of the manufacturers, especially with regard to temperature control, which should be in the range of 2°C to 8°C<sup>43</sup>. According to the MH<sup>44</sup>, the organization of the national cold chain used in the immunization plan has the logistics structure of the Logistics Department (DLOG) and the General Logistics Coordination (CGLOG) of Strategic Inputs for Health of the MH, and the performance of the logistics operator in this strategy is fundamental to achieve the objective.

## Final considerations

Seen in isolation, logistics is not a specific field of study of health, but, from the multidisciplinary view of collective health, it makes an

important contribution by moving health goods and services through the territories, serving as an important management resource for policies in the areas of health and economics, making access to technologies generated by the development process effective.

Over time, as industries were transformed through the industrial revolutions that guided the economic and social development of nations, important technological innovations were developed. During this period, the world was affected by crises with an impact on essential sectors of the economy that tested resilience and demanded a global effort to overcome it, and logistics participates directly in this scenario by moving the technologies generated in industries, positioning stocks at points of consumption according to the needs of universal health systems.

Health is an important segment of the economy with a HEIC that operates in the social and economic dimensions of development, producing high-tech goods and services. To fulfill this mission, the productive base of health depends on not interrupting the supply chains in which logistics has a strategic participation.

Despite the important participation of logistics in the development of countries, there is no participation of this sector in the discussion and formulation of health policies. In this sense, it is necessary that logistics specialists be part of the elaboration of public policies or be heard in decision-making, so that they can be aligned with the demands of health systems and the real needs of the population.

While there is an understanding that logistics and supply chain are important for industry development, there is little investment in these areas, and experts in supply chain management and logistics do not participate in policymaking involving the industry<sup>45</sup>. Thinking about the potential of health to contribute to an integrated vision

of development<sup>46</sup>, it is necessary to consider all aspects that enhance such contribution in a vision aligned with the concept of universal access to health.

In the case of medicines and vaccines, because they are health technologies with specific characteristics, they need to be moved within specific standards. Logistics, through pharmaceutical logistics, is the segment of the productive sector that contributes to health development reaching, in fact, those who need it, in the correct form and in the necessary place, giving it effectiveness, since development without equal access becomes incomplete or ineffective<sup>47</sup>.

The protagonism of logistics in health is shown by its performance in two dimensions of development: economic – adding value to technologies during their movement – and social – allowing people who do not have conditions and locations that do not have infrastructure to have effective access to health.

COVID-19 vaccination evidenced the historical disarray in the distribution and access to vaccines, with the richest and most developed cities advancing faster in immunizing the population in relation to other cities, forcing their populations to occasionally travel up to 3,000 km<sup>48</sup> to be vaccinated, or immunizing populations less in need before those more in need, because they are located in large centers with better development rates. This is a major challenge for SUS, and the participation of logistics minimizes the problem, moving vaccines to all necessary locations and providing equitable access.

Today's worldwide discussion of what the post-pandemic economies will look like focuses on the need to internalize production to reduce external dependence on the supply of important items for the production of strategic goods to local economies.

The need for an industrial policy that strengthens domestic production as a strategy to overcome the health crisis involves the contribution of logistics, which, due to its historical importance and protagonism

in the development of economies, cannot be left out of this agenda. In this debate, it is extremely important to participate in the sector that moves the inputs necessary for industries to produce their technologies, in addition to distributing production throughout the territories.

In the case of health, the need for the participation of logistics in the discussion on the way out of the health crisis and the resumption of economic growth is even more evident if we consider that, at the same time that it supplies the HEIC industries, it moves all the production, highlighting its importance for health policies.

The strengthening of the HEIC concept goes through its productive dynamics. The materials and inputs used by the chemical and biotechnology-based and mechanical-based industries need to have a guarantee that they will reach them. Also, the technologies generated in these subsystems need to reach the health services, turning the economy around and making the productive dynamics of the complex effective, and the performance of logistics is strategic for this process.

The production and innovation in health addressed by the complex, as a political, economic and social space, when materialized through a technology, need to be available to all. However, without a logistics structure that allows the supply of the HEIC production chain and the access of everyone to its production in an equitable way, this approach is impaired.

Innovation and development need to be accompanied by access. Universal health systems need the services offered to be accessible by all so that they are effectively universal, and logistics, through the capillarity of its activities, has great potential to contribute to more equal access to the benefits of development and health technologies.

Based on this study, the protagonism of logistics in technological revolutions over the years has been important for the development of nations, acting strategically in all segments

of the economy with a prominent participation in health, and as an important resource for maintaining the operation of production chains and guaranteeing access.

This study sought to highlight the central elements of logistics that contribute to strengthen an agenda that articulates HEIC with universal access, thinking about the sustainability of SUS and logistical factors as critical elements without which access does not materialize.

Major challenges need to be faced to improve access to health services and their technologies, especially medicines and vaccines that are of great technical and technological complexity, requiring controls and special care. The challenges include the need to improve the national logistics operation on issues related to the health sector, and to think about improving infrastructure for the most distant regions of the country that do not yet have technologies in data collection to monitor, in real time, logistics operations and use them to make decisions that allow the distribution of health production more equally to the regions that need it most, ensuring that the population of the North and Northeast have access to

it with the same quality and quantity as the population of the other regions with better infrastructure.

It is necessary that themes such as these be further explored in knowledge production environments to stimulate debate and the participation of other sciences in the formulation of policies that contribute to the economic development and sustainability of SUS.

The last logistics mile, which serves the supply of urban centers and residences, is a characteristic of logistics that was not included in this study, despite its importance for coping with the pandemic when it guaranteed the operation of essential activities and remote work during social isolation. This was a limitation of this study, which was dedicated to addressing the participation of logistics in health from the perspective of the production base and guarantee of access.

## Collaborators

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