Inter-American Development Bank

Toward the Future of Healthcare Workers: upcoming trends and challenges

Social Protection and Health Division

Ricardo Pérez Cuevas
William Savedoff
Gustavo Nigenda
Svetlana Doubova
Rita Elizabeth Sorio
Mario Dal Poz

TECHNICAL NOTE Nº
IDB-TN-02706

May 2023

Toward the Future of Healthcare Workers: upcoming trends and challenges

Ricardo Pérez Cuevas
William Savedoff
Gustavo Nigenda
Svetlana Doubova
Rita Elizabeth Sorio
Mario Dal Poz

May 2023

IDB
Inter-American Development Bank

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Toward the future of healthcare workers: upcoming trends and challenges / Ricardo Pérez Cuevas, William Savedoff, Gustavo Nigenda, Svetlana Doubova, Rita Elizabeth Sorio, Mario Dal Poz.
p. cm. – (IDB Technical Note ; 2706)
Includes bibliographical references.
1. Public health personnel-Latin America. 2. Public health personnel-Caribbean Area. 3. Telecommunication in medicine-Latin America. 4. Telecommunication in medicine-Caribbean Area. 5. Coronavirus infections-Social aspects-Latin America. 6. Coronavirus infections-Social aspects-Caribbean Area. I. Perez-Cuevas, Ricardo. II. Savedoff, William D. III. Nigenda, Gustavo. IV. Doubova, Svetlana. V. Sorio, Rita. VI. Poz, Mario Roberto Dal. VII. Inter-American Development Bank. Social Protection and Health Division. VIII. Series.
IDB-TN-2706

scl-sph@iadb.org

www.iadb.org/SocialProtection

Toward the **Future** of **Healthcare Workers**: upcoming trends and challenges

Ricardo Pérez Cuevas
William Savedoff
Gustavo Nigenda
Svetlana Doubova
Rita Elizabeth Sorio
Mario Dal Poz

IDB

Contents

Introduction

In Latin America and the Caribbean, the decisive factors for the future health workforce are manifold. The health workforce[a] is the backbone of healthcare, with the common goal of improving the health of individuals and populations, but its characteristics, competencies and functions are evolving gradually. In attempting to predict the attributes and roles of the health workforce in the future, it is essential to examine social, occupational, cultural and technological contexts and trends, including those related to health, education and the environment.

In this sense, it is appropriate to use futuristic frameworks to outline what might happen and the potential impact, considering different alternatives.[1] This approach helps to identify possible scenarios and to plan actions to close the gaps between preferred and probable futures.[b] For example, digital and genomic literacy of healthcare personnel cannot be postponed, both for those in training and for those who routinely provide care to users. Maintaining the *status quo* without considering this currently unmet need represents a reduction in the capabilities and competencies of the healthcare workforce for the foreseeable future.

This paper establishes an analytical framework that attempts to anticipate what is possible and desirable in the area of HCWs and seeks to establish the influence of: (i) policies aimed at achieving universal coverage; (ii) demographic trends and population health needs, such as chronic diseases, public health emergencies and climate change; (iii) the convergence of technological innovation; and (iv) users participation in healthcare.

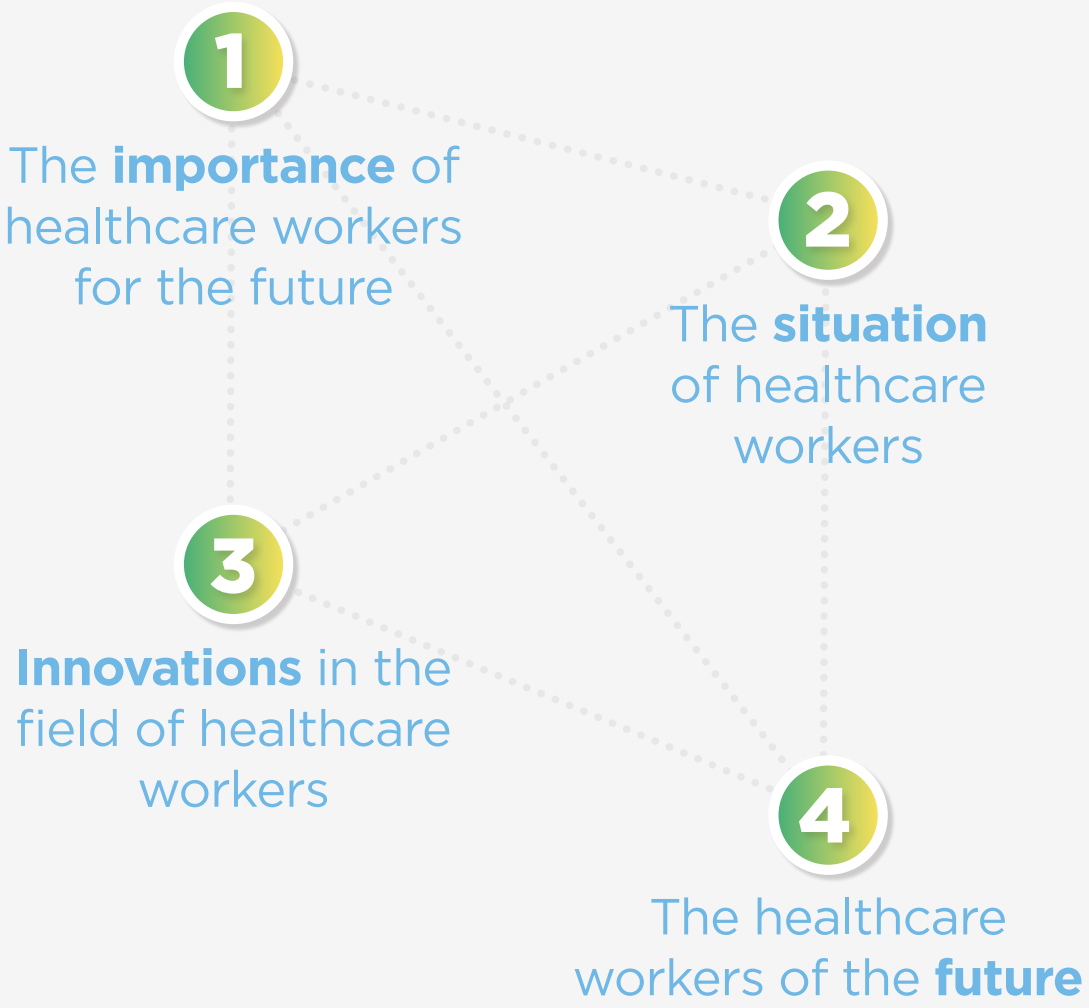
In response to these circumstances, this publication provides useful elements to understand the context and identify the importance for health and education systems to prepare, adapt and promote the necessary changes to shape the future competencies,[c] roles and diversity of the health workforce that Latin America and the Caribbean will require in the coming decades.

a. The World Health Organization (WHO) defines the health workforce as "all people involved in activities intended to improve health" and includes those who provide services (doctors, nurses, midwives, dentists, community HCWs and social HCWs), as well as those who are responsible for directing and organizing the operation of the health system, such as managers, administrators or directors.

b. Plausible futures refer to what could happen according to current knowledge of how things work and without changing the trend. Preferable futures are what is desired to happen and for this, knowledge and conditions are actively created to make it a reality.

c. Competencies are the skills, abilities, knowledge, behavior and attitudes that are instrumental in achieving desired results and job performance.

This paper discusses four interconnected areas:



1

The **importance** of healthcare workers for the future

Estimating the future health workforce is essential for health systems to effectively fulfill their social function. Health workforce planning requires defining their number, competencies and functions and distribution in relation to the health needs of the population, as well as the characteristics of the health systems.[2] There are different techniques for estimating future requirements.[3,4] For example, Chile, Peru[5] and Mexico[6] have published approaches to planning the health workforce. The Organisation for Economic Co-operation and Development (OECD) conducted simulations of the future supply and requirements of nurses, midwives and medical doctors in OECD member countries. The techniques used demonstrated their potential usefulness in helping countries to increase the availability of health care HCWs (HCWs.)[7,8] This type of exercise, however, faces several challenges. On the one hand, there is the challenge of generating reliable estimates based on administrative data that are not always updated and, on the other, the fact that decisionmakers must use the evidence derived from the estimates to generate medium- and long-term public policies in the areas of education and labor.

Determining the number, knowledge, skills and abilities of healthcare workers requires different parameters. The variables of analysis include sociodemographic characteristics of the population, such as birth rate, territorial distribution by sex and social stratum, health status, morbidity, and mortality. In addition, the availability, demographics, training levels, competencies, working conditions and functions of HCWs, as well as the technology available for them to perform their tasks, must be known. It is also necessary to know the existing educational offerings for HCWs. In the context of each country, there are multiple determining factors: for example, the public and private resources available to invest in infrastructure, technology and HCWs, or the conditions of the healthcare market.

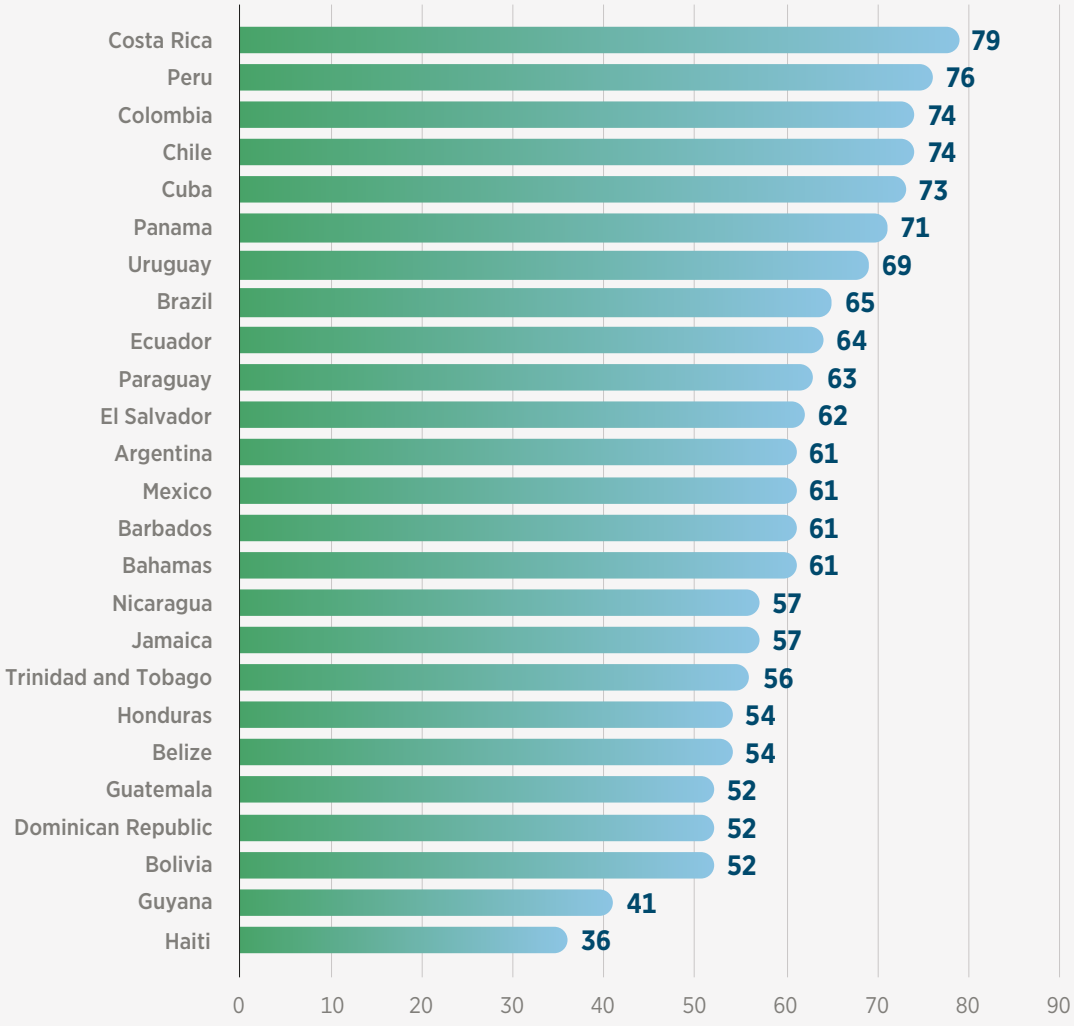
This section briefly describes trends in some of the factors that will determine the future competencies of the healthcare workforce in Latin America and the Caribbean: access to health services; population aging; chronic non-transmissible diseases, including mental health; public health emergencies and climate change; and user participation.

Access to healthcare services is still not universal

The goal of guaranteeing universal coverage has not yet been achieved in Latin America and the Caribbean. Future actions should continue efforts to close the gap between those who have access to health services and those who do not. Some countries have implemented reforms to expand access to health services through public insurance programs and strengthening their health systems, such as Brazil, Chile, Colombia and Costa Rica. However, large disparities persist in the achievement of universal coverage, with gaps in access and quality of services. The Universal Health Coverage effective coverage index (Chart 1.1) represents the coverage of services with respect to healthcare needs and the contribution of these services to improving the health status of the population. The Institute for Health Metrics and Evaluation index uses 23 indicators of effective coverage. The indicators are based on outcome measures such as mortality ratios or access to quality healthcare services.[9] The index is interpreted from 0 to 100. Chart 1.1 presents effective coverage in Latin American and Caribbean countries. The difference between countries indicates that the population faces significant barriers to accessing quality healthcare services. Countries should continue to strive to achieve universal coverage, focusing on reducing health inequities and ensuring that individuals can access services that allow them to maintain or improve their health without the risk of impoverishment.[10]

CHART 1.1

UNIVERSAL HEALTHCARE COVERAGE EFFECTIVE COVERAGE INDEX



Source: Institute for Health Metrics and Evaluation.

The population is aging rapidly, but getting sicker

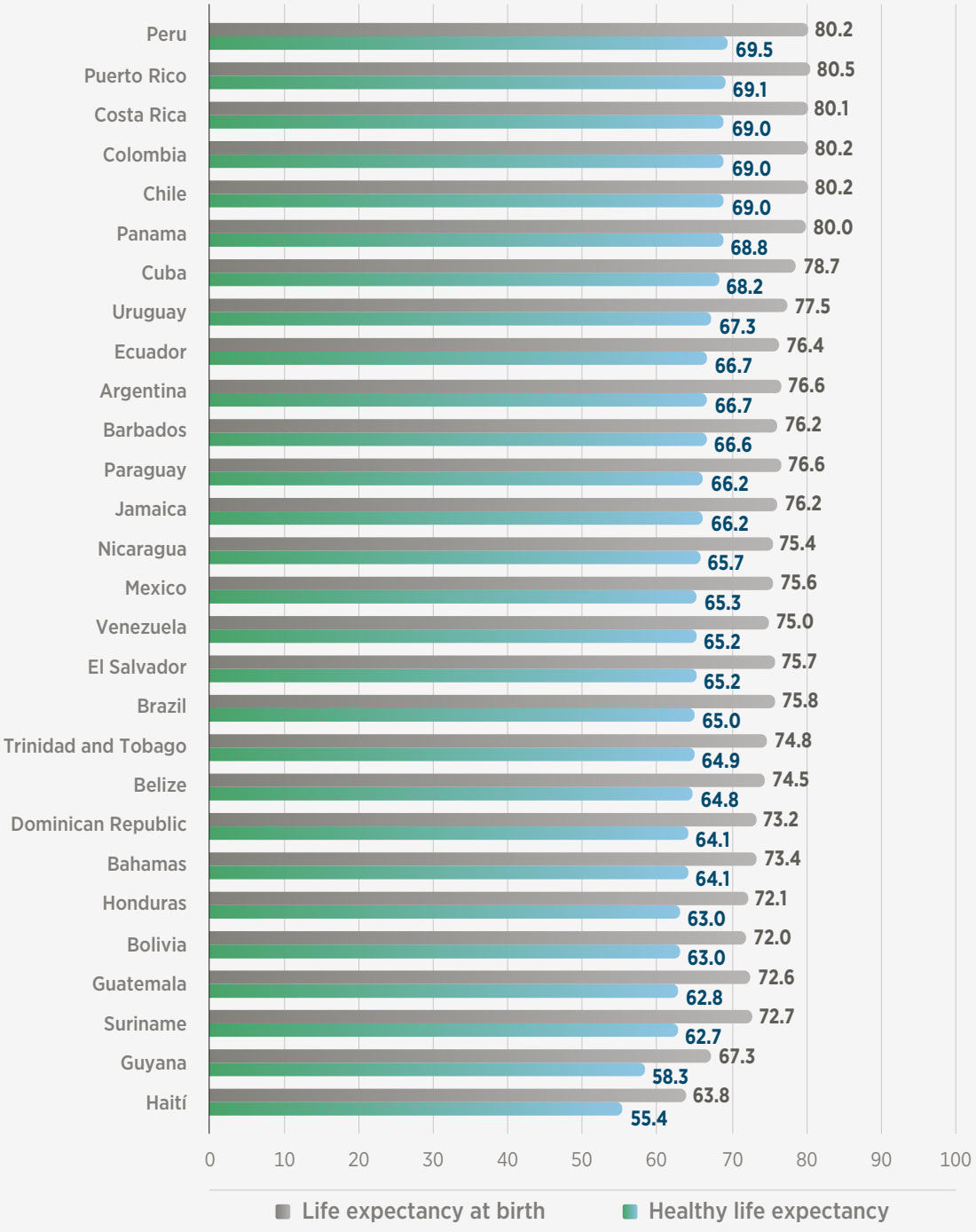
Latin America and the Caribbean is experiencing a progressive increase in the proportion of older adults. People aged 65 and over currently represent 11.2% of the total population, ranging from 9.6% in Central America to 13.2% in the Caribbean. The trend is increasing, as the population is aging at an annual rate of +3.7%.[11] By 2050, more than 25% of the region's population will be 60 years of age or older.[12]

Today's older adults live longer, but their health is more impaired. Between 1960 and 2017, average life expectancy in Latin America and the Caribbean increased from 56 to 76 years, although there are differences between countries. Among IDB members, Haiti has the shortest life expectancy (61 years), while Peru has the longest (80 years).[13] The proportion of older adults will continue to increase. Thus, by 2030, approximately 15% of older adults will be 80 years of age or older.[14] However, as in other regions of the world with high levels of poverty and limited access to health services, older adults in Latin America and the Caribbean have a higher burden of disease compared to younger age groups. Between 55% and 95% suffer from one or more chronic noncommunicable diseases (NCDs).[15] Among countries in the region, there are tangible differences in the health status of older adults, as measured by the number of years in good health. For example, the differences in the two countries mentioned above are tangible. In Peru, the healthy life expectancy is 69.6 years. In Haiti, on the other hand, it is 55.4 years (Chart 1.2).

Healthcare workers will need to acquire different competencies to care for older adults. The aging population requires, now and in the future, more healthcare and social workers to provide coordinated and accessible health and social services at home, in the community, in social centers and in health facilities. An increase in the need for HCWs trained to provide care for dependent persons and a reduction in the informal supply of care services is foreseen, which will possibly lead to the formalization of these services and a greater demand for HCWs. It should be kept in mind that the global trend and the preferences of older adults are to age at home, so that home services provided by qualified HCWs will be in increasing demand.

CHART 1.2

LIFE EXPECTANCY AND HEALTHY LIFE YEARS



Source: Institute for Health Metrics and Evaluation.

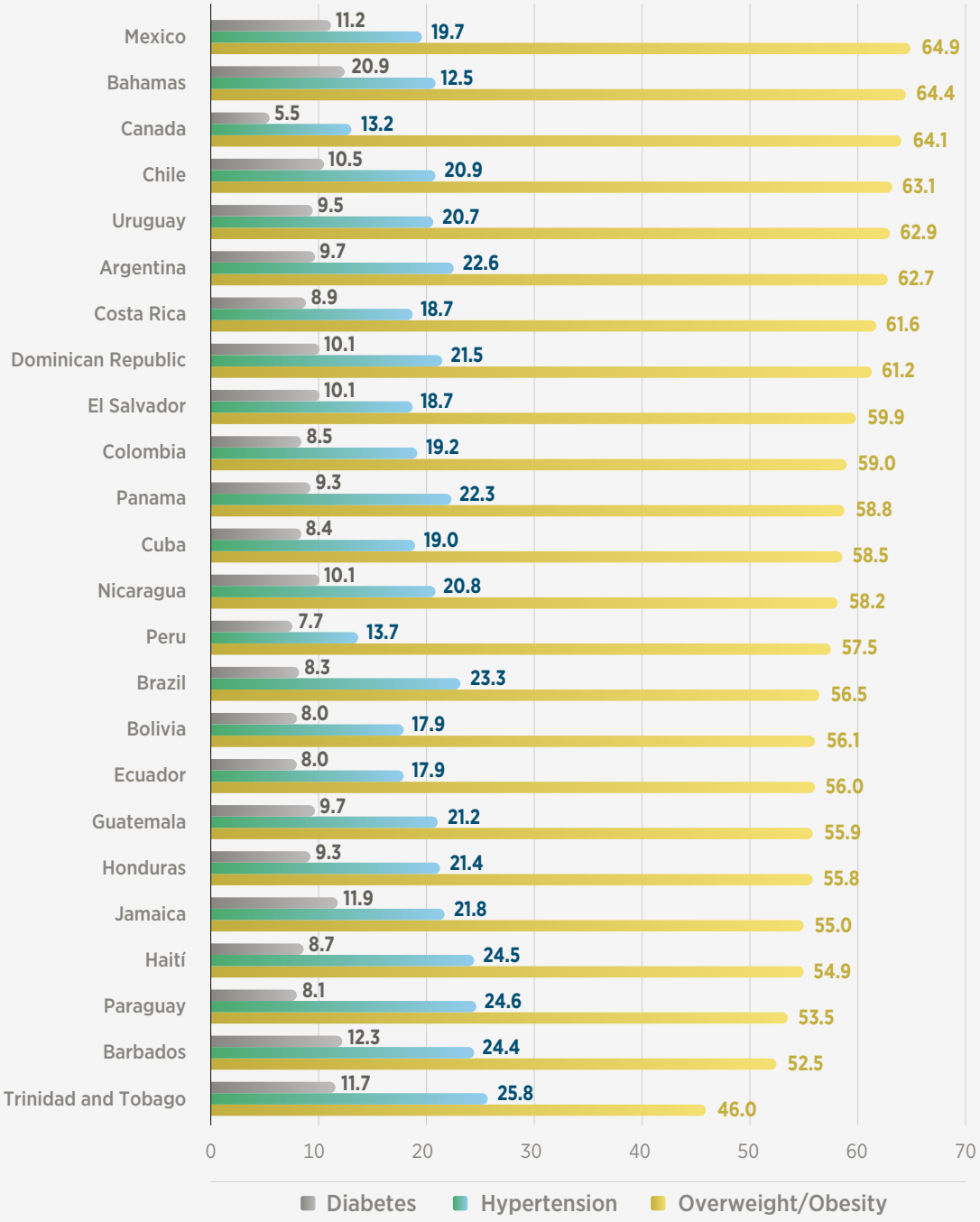
Patients with chronic conditions will continue to increase

The proportion of the population suffering from chronic noncommunicable diseases is high in the region and will continue to rise. The most frequent NCDs are overweight/obesity (60%), hypertension (22%) and diabetes (9%). Although these percentages vary between countries, their distribution is similar. For example, Mexico has the highest prevalence of overweight/obese (>65%); Caribbean countries have on average, prevalence of diabetes close to 12%, while Trinidad and Tobago has a 25% prevalence of hypertension (Chart 1.3). Consequently, NCDs are the leading cause of outpatient and inpatient care, responsible for 80.7% of all deaths. Of this total, 38.9% are premature deaths in people under 70 years of age, a trend that will continue in the coming decades.[16]

Mental health disorders are a growing health problem in Latin America. The Institute for Health Metrics and Evaluation has reported that mental disorders are among the 10 leading causes of disease burden and their trend is increasing.[17] Depression and anxiety are among the most common mental health disorders in the region (5.8% and 9.3%, respectively). Consequently, depression and anxiety account for 5.6% and 4.95%, respectively, of the total years lived with disability, a burden that is also higher in Latin America compared to the global average. Other mental health disorders, such as substance abuse, bipolar disorder and schizophrenia, also affect a significant portion of the population in Latin America. The increasing trend of mental health disorders in the region may be influenced by various factors, such as poverty, violence, social inequality and limited access to mental health services. In this regard, the stigma associated with mental illness also contributes to the underreporting of cases and lack of adequate treatment.

CHART 1.3

PREVALENCE OF OVERWEIGHT/OBESITY, HYPERTENSION AND DIABETES



Source: Prepared by the authors based on data from the Health Information Platform for the Americas (PLUSA), Pan American Health Organization.

Preparedness and response to public health emergencies is precarious

The COVID-19 pandemic had severe effects in Latin America and the Caribbean. Precariousness, poor preparedness of HCWs and the slowness of public health and medical care services to respond to the health crisis were visible in the region.[18] By February 2023, Latin America and the Caribbean had registered 189.6 million cases[19] (28.1% of the global total) and 2.9 million deaths (42.3% of the global total). In other words, by February 2023, the American continent - with only 13% of the world's population – had already accounted for most global deaths due to COVID-19. One of the indicators to measure the severity of the magnitude of the pandemic is excess mortality.[d] Thus, the countries in the region with the highest excess mortality rates per 100,000 inhabitants were Bolivia (734.9), Peru (528.6), Ecuador (333.4), Mexico (325) and Honduras (297).[20]

The COVID-19 pandemic brought to light inequities and barriers to access to essential services. The prioritization of emergency care required governments to redirect financial resources, HCWs and adapt hospitals and clinics for COVID-19 cases. As a result, the supply of essential services was reduced. Preventive, outpatient and inpatient healthcare services faced severe disruptions during 2020 and 2021. Several studies reported the magnitude of the reduction in preventive and curative services in Latin America and the Caribbean.[21,22] For example, Mexico reduced the use of vaccines from regular childhood vaccination programs to less than 30%;[23] Chile, Haiti and Mexico reduced consultations for diabetes and hypertension by more than 20%.[24] Brazil, Chile, El Salvador and Mexico reduced hospitalizations by 20-40%. Demand for services also contracted due to fear of contagion among the population and measures of confinement and social distancing, among other causes.

In the future, Latin America and the Caribbean will continue to face challenges in dealing with public health emergencies. There are multiple determinants of public health emergencies. For example, the population density of many cities, the precariousness of basic services such as water and drainage, the shortage of public health services and HCWs, and the lack of investment in epidemiological surveillance and emergency response programs. The preparedness, response, and recovery of health systems to emergencies and disasters will need to be strengthened in most countries of the region.

d. The measure of excess mortality is defined as the net difference between the number of deaths during the pandemic (as measured by estimated or observed all-cause mortality) and the number of deaths that could have been expected based on previous trends in all causes of mortality.

Climate change will have a significant impact on population health

Climate change has multiple effects on health. Climate change has an impact on the social and environmental determinants of health.[25] Thus, the most vulnerable populations living in remote communities or with infrastructure that is not very resilient to possible disasters are the most affected, which causes displacement and migration and increases the risk of impoverishment and deterioration of their health status. Many diseases are sensitive to climate change. Between 2030 and 2050, climate change could cause up to 250,000 additional deaths annually from malnutrition, malaria and diarrhea.[26] Increasingly frequent heat waves, prolonged droughts and intense storms affect agriculture and food production, resulting in food insecurity and malnutrition.[27] A growing number of people in increasingly large geographic regions are exposed to vector-borne diseases such as malaria, dengue and chikungunya .[28,29] Catastrophic events —such as hurricanes, storms, and floods— increase the risk of injury and death.[30] Extremely hot days are associated with increased cases of dehydration, heat stroke, mortality in older adults with cardiovascular disease, and increased risk of renal and cardiovascular disease.[31] Pollution from wildfires exacerbates respiratory ailments. Climate change also generates mental health problems: between 11% and 38% of people affected by natural disasters suffer from mental disturbances related to stress and other emotional adjustment problems.[32]

Health systems will face more challenges to respond to the climate change. The WHO Climate Change and Health Survey 2017/2018 identified gaps and barriers to health systems' adaptation and mitigation actions in the face of climate change. This survey was responded to by 101 countries, including 27 from the Americas. About 45 countries had health and climate change plans or strategies in place and only 8 had initiated implementation of specific plans. The main barriers to implementing plans and strategies to address climate change and health are insufficient funding, weak leadership and governance, lack of HCWs competencies and methodological tools. In terms of HCWs, only 12 out of 101 countries had developed a national curriculum to train HCWs on the health impacts of climate change.[33]

Users must be part of health services' improvement

The user's perspective is fundamental. User participation is increasingly important for improving the quality of healthcare. Positive experience with health services is associated with a perception of high quality care,[34] improved self-perception of health,[35] greater satisfaction[36] and trust in services, as well as better health outcomes.[37] In addition, users who participate in decisions on the organization and provision of services have the certainty that their expectations will be met, which favors health system transparency.

The user's perspective should be included in actions to improve the effectiveness of health services. The user's perspective is not yet a key input for designing and improving health services congruent with the needs, preferences or expectations of the population. It is common for HCWs to underreport the benefits, risks and uncertainty related to potential outcomes of medical procedures. Health services are rarely accountable to users or consider them as an active part of the design or improvement of services.

In general, users lack a voice in improving or modifying the structure of health services. Frequently, users, mainly those suffering from NCDs, due to the lack of coordination and attention of services, suffer interruptions in their care, are referred and rejected from multiple services, and have to explain and repeat many times the history of their condition to different HCWs. The result for users is frustration, wasted time and resources. For the health system, this represents duplication of health services, inefficiencies, unnecessary procedures and increased cost.[38]

Users express their expectations and unmet needs in multiple ways. In Colombia[39] and Mexico,[40] users have expressed their expectation that medical doctorsmedical doctorshould have better communication skills and a greater ability to recognize their preferences and the right to express their opinions and ask questions. A study in 17 countries in Latin America and the Caribbean reported that users were dissatisfied with services due to problems of access and the costs of care.[41]

The IDB conducted the Survey on Access, Experience and Coordination of Primary Healthcare in Latin America and the Caribbean[42] in Brazil, Colombia, El Salvador, Jamaica, Mexico, and Panama, in which 8871 health service users participated. The survey examined the attributes of patient-centered primary care: access, coordination, communication between HCWs and patients, provision of health-related information, and emotional support. The results identified significant gaps in the provision of user-centered primary care among countries (Table 1.1).

TABLE 1.1

USERS' EXPERIENCES WITH PRIMARY CARE SERVICES IN SIX LATIN AMERICAN COUNTRIES

Domain	Experiences	Brazil n=1500	Colombia n=1463	El Salvador n=1460	Jamaica n=1488	Mexico n=1488	Panama n=1472
User experience with primary care	Has a doctor or regular health services (%)	27.7	31.8	35.5	61.2	61.8	56.1
	Understands the information provided by the medical doctor (%)	65.9	78.6	71.2	67.8	78.8	75.8
	The doctor solves most of their ailments (%)	53.7	71.6	70.4	58.8	80.5	74.5
	Perceives that they receive very good quality services (%)	27.1	27.8	45.5	51.3	35.4	32.2
	Delayed diagnosis (%)	12.8	19.5	22.0	24.2	15.8	22.1
Coordination between primary and specialized care	Referral for specialty care is made by your regular medical doctor (%)	78.7	77.6	70.4	54.7	70.0	68.0
	Specialist had medical information from the primary care medical doctor (%)	31.8	44.2	60.0	63.0	62.8	62.5
	The primary care medical doctor was informed of the specialist's recommendations (%).	29.9	51.2	52.3	58.5	67.4	56.4
Patient-centered primary care		3.1	7.5	8.1	14.1	12.8	8.0

Source: Survey on Access, Experience and Coordination of Primary Healthcare in Latin America and the Caribbean (2018).

2

The **situation** of healthcare workers in Latin America and the Caribbean

Policies aimed at the health workforce face challenges

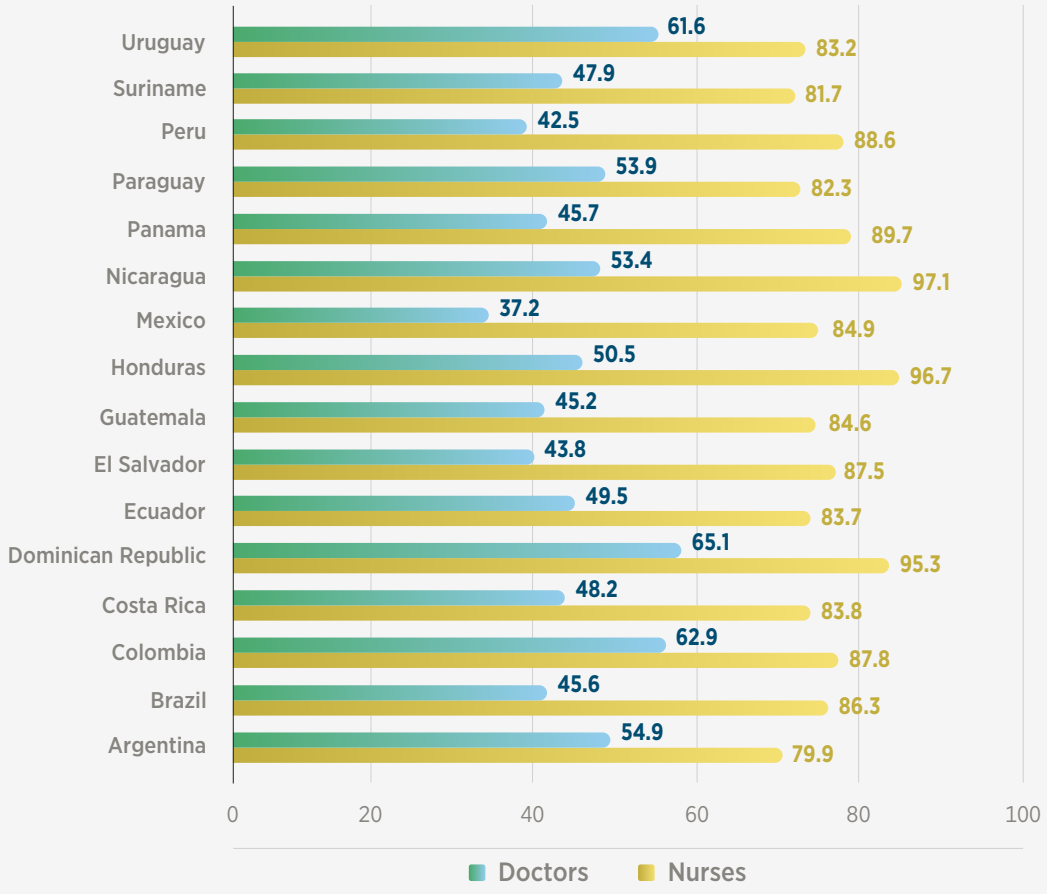
Health workforce policies face weaknesses in governance, regulation and management, insufficient financing and incomplete information. Health systems have limitations in accurately identifying the current situation and needs, as well as in estimating the number and competencies of HCWs needed in the future. In the day-to-day provision of health services, the problem includes deficiencies in the availability, distribution and skills of HCWs, and limitations in evaluating and improving their performance. In the labor context, HCWs face precarious contractual conditions and resources for their daily work, occupational hazards, unemployment, underemployment, insufficient training opportunities, work overload and low salaries, which translates into low productivity, poor performance, lack of incentives and job burnout.[43] In addition, there are inequalities by gender, professional level, function and enormous difficulties in forming work teams. The shortage of professionals is also aggravated by high rates of migration in some countries. For example, in Jamaica and Peru, between 36% and 40% of professional HCWs migrate in search of better employment conditions and income.[44,45]

The healthcare workforce is predominantly female and aging

Women are increasingly participating in all health disciplines, although they face labor disparities with respect to men. In Latin America, women represent approximately 72.8% of HCWs,[46] 57% of medical doctors and 87% of nurses (Chart 2.1). Their presence is particularly predominant in different medical specialties, such as endocrinology,[47] gynecology and obstetrics.[48] However, women still face excessively rigid work schedules to maintain work-life balance, as they take on family roles in addition to their jobs. At the same time, women continue to face income disparities, which are between 25 and 28% lower than those earned by men for performing the same functions. Women also have less opportunity to occupy management positions: less than 30% of management positions are held by women.[49,50] In other professions, women are well represented. In education, for example, 65% of primary school teachers are women. However, ECLAC has reported that gender segmentation continues in education and in technical and professional training. The percentage of women graduates from science, technology, engineering and mathematics (STEM) careers, compared to men, varies between 25% and 47% in Latin America and the Caribbean.[51]

CHART 2.1

PERCENTAGE OF NURSES AND DOCTORS

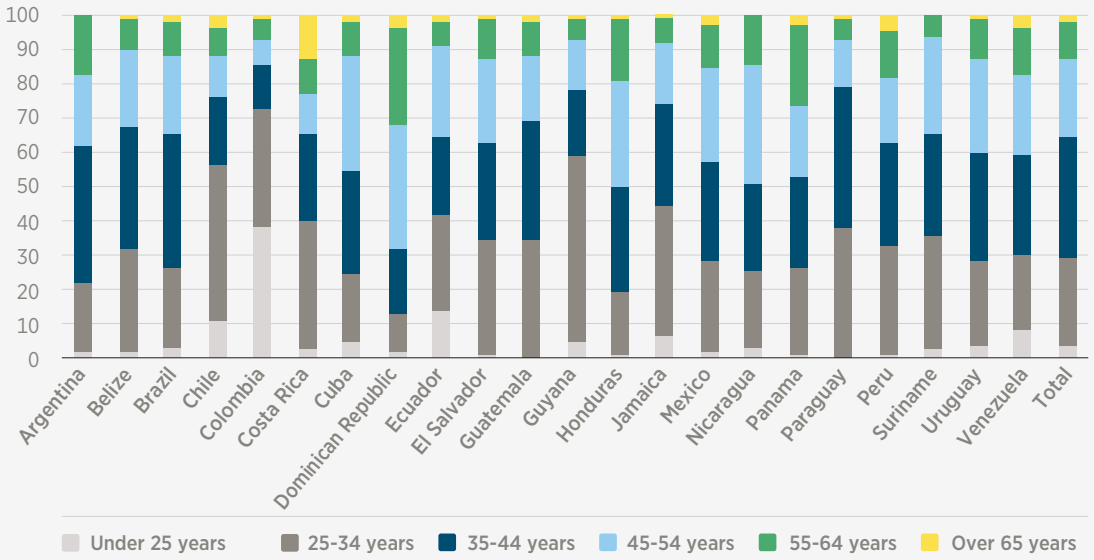


Source: National Health Workforce Accounts Data Portal (NHWA), World Health Organization. Accessed December 2022.

Changing demographics of the healthcare workforce will affect its availability in the region. The *baby boom generation* is about to reach retirement age and the working-age population is shrinking. In 2020, the average age of nurses in Latin America and the Caribbean was over 40 years old and more than 30% were over 50 years old. For example, in Cuba, the Dominican Republic, Honduras, Mexico, Nicaragua, Panama, Uruguay and Venezuela, more than 40% of nurses were over 45 years old (Chart 2.2). As for medical doctors, the average age was 45 years and 25% were over 65 years old. For example, in Argentina, Brazil, Chile, Dominican Republic, Guatemala, Mexico, and Uruguay, more than 25% of medical doctors are 55 years of age or older, and 17% are older than 65 years[52,53,54] (Chart 2.3). These figures indicate that a significant proportion will reach retirement age in the short term. Similarly, the average age also points to the need to develop urgent actions aimed at the replacement of HCWs, especially if it is taken into account that replacement is not immediate: the training of a medical doctor requires six years and those who access postgraduate courses need several more years before formally joining the workforce. The supply of educational sites has not grown in congruence with the needs. Therefore, it is important to implement strategies to reduce the historical lags and maintain the appropriate supply of HCWs in congruence with the size of the population and its epidemiological profile. Knowledge of worker demographics makes it possible to know the number of positions that will eventually have to be replaced and to determine the size of the educational supply needed to achieve the number of health professionals that are indispensable. Chile stands out in this regard because it monitors HCWs in order to implement measures aimed at reducing the shortage.[55] There is also a noticeable tendency for people to lengthen their retirement period. In 1980, people worked for an average of 36 years and, by 2050, it is estimated that they will work for 42 years.[56]

CHART 2.2

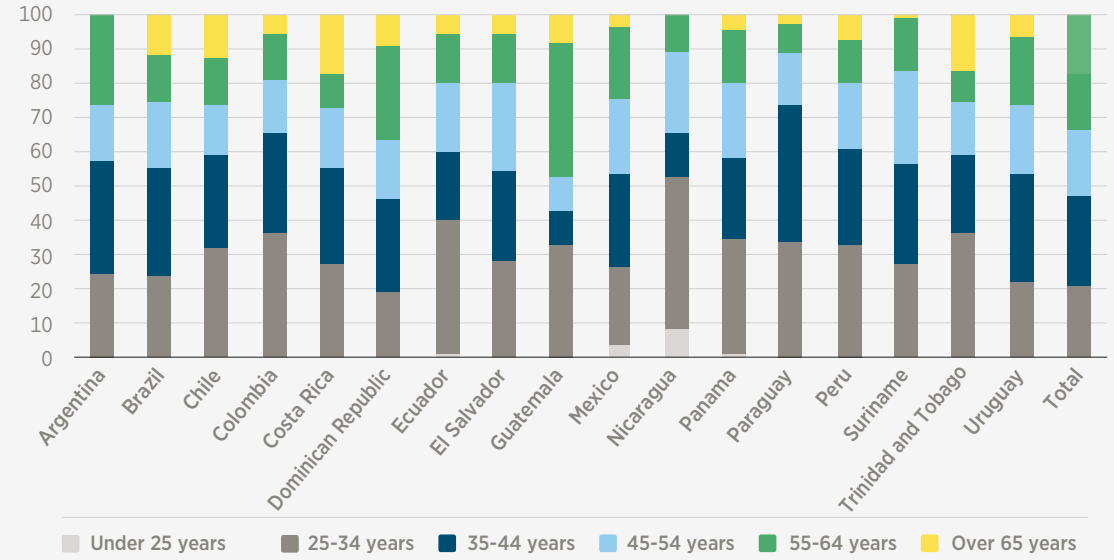
AGE DISTRIBUTION OF NURSES IN LATIN AMERICA AND THE CARIBBEAN



Source: National Health Workforce Accounts Data Portal (NHWA), World Health Organization. Accessed December 2022.

CHART 2.3

AGE DISTRIBUTION OF MEDICAL DOCTORS IN LATIN AMERICA



Source: National Health Workforce Accounts Data Portal (NHWA), World Health Organization. Accessed December 2022.

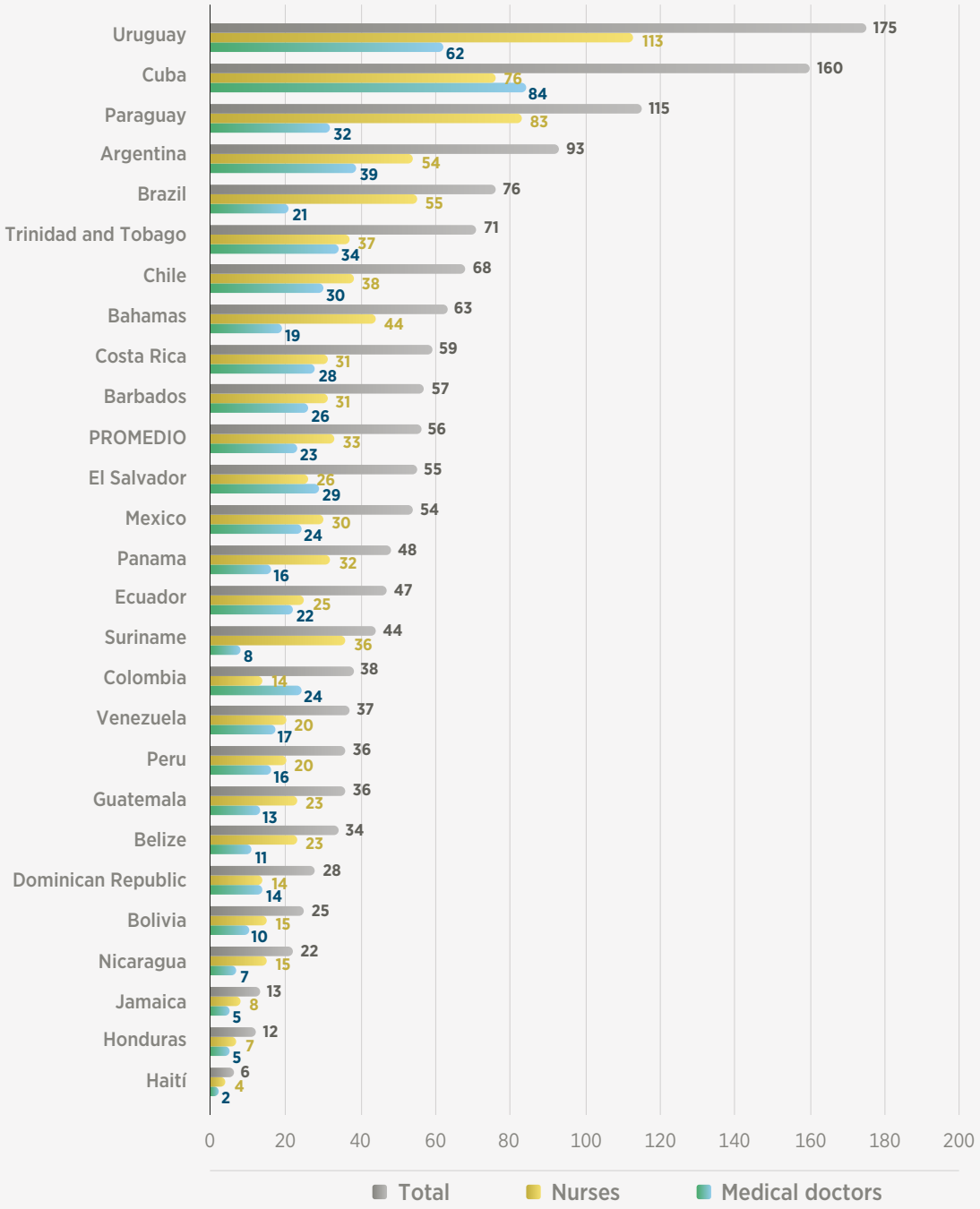
Latin America and the Caribbean has a shortage of healthcare workers

Latin America and the Caribbean still does not have enough healthcare workers. It is a goal for the region to have 2.6 million HCWs by 2030.[57] On average, Latin America and the Caribbean has 23 medical doctors and 33 nurses for every 100,000 inhabitants (Chart 2.4), a figure (56 per 100,000) that exceeds the criterion recommended by the World Health Organization (WHO), which establishes that countries should have 44.5 health resources (doctors, nurses and midwives) for every 100,000 inhabitants (Chart 2.5) to provide essential services.[58,59] However, it is important to mention that this criterion is a minimum threshold. Among countries, disparities are visible, with a range of 2 to 84 medical doctors per 100,000 population. Although 15 countries meet the recommended criterion, 11 still lack sufficient HCWs. Uruguay, Cuba, Paraguay, Argentina and Brazil stand out with the highest number of medical doctors and nurses, while Haiti, Honduras, Jamaica, Nicaragua and Bolivia are the countries with the fewest medical doctors and nurses. Chart 2.4 presents this information in descending order according to the total number of HCWs and the distribution of medical doctors and nurses per 100,000 population.

Having the required number of healthcare workers is necessary, but not sufficient. The inequitable distribution of HCWs is an unresolved problem. In addition to the indispensable number, it is necessary to consider that the HCWs be distributed in such a way that the entire population has access to care. In general, the distribution of HCWs in Latin America and the Caribbean is uneven, with a shortage rs in rural and remote areas, and a concentration in urban and wealthier areas.[60] Analysis of the distribution of HCWs in Colombia, Costa Rica, Jamaica, Panama, Peru and Uruguay indicates the imbalance of HCWs. Rural communities have limited access to services. In these countries, with the exception of Jamaica, programs have been established to promote HCWs working in remote areas, including training of personnel in intercultural competencies. Costa Rica and Uruguay recruit at least 30% of HCWs to work in their own communities.[61]

CHART 2.4

DENSITY OF MEDICAL DOCTORS AND NURSES PER 100,000 INHABITANTS IN LATIN AMERICA AND THE CARIBBEAN



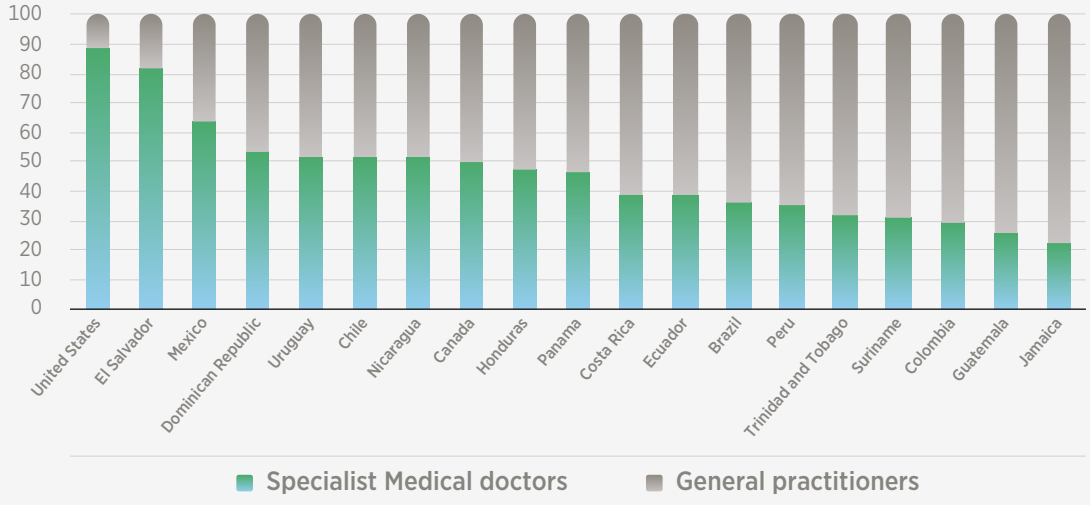
Source: National Health Workforce Accounts Data Portal (NHWA), World Health Organization. Accessed December 2022.

There are disparities in the availability of specialist medical doctors in Latin America and the Caribbean. Data from the WHO health workforce portal show that in some countries, half or more of the medical doctors have a specialty, such as El Salvador, Mexico, the Dominican Republic, Uruguay, Chile, and Nicaragua, while in other countries (such as Colombia, Guatemala, and Jamaica) less than 30% of medical doctors are specialists (Chart 2.5).

There are multiple factors that determine the number of specialist medical doctors in a health system. The disparity is related to the unequal distribution of HCWs and infrastructure in the region. Countries have limited resources to invest in the training and recruitment of medical specialists. The capacity of the educational system to incorporate and train aspiring specialists and the capacity of the health system to employ and retain specialist medical doctors is another decisive factor. Educational and labor policies towards medical doctor specialists mainly define their retention, turnover and migration. In fact, the migration of specialist medical doctors to countries that offer better employment and professional development opportunities is a well-documented situation.[62,63]

CHART 2.5

PERCENTAGE OF SPECIALIST MEDICAL DOCTORS IN RELATION TO GENERAL PRACTITIONERS



Source: The Global Health Observatory, World Health Organization.

In general, there is a shortage and asymmetry in the distribution of medical doctors with medical and surgical specialties. Brazil has reported a shortage and asymmetry in the distribution of surgical specialties. There are 95,169 surgeons, anesthesiologists and obstetricians in this country. The density of surgeons is 46.55 per 100,000 inhabitants. However, a territorial analysis shows great disparities in its distribution, varying from 20 professionals per 100,000 inhabitants in the Northern Region to 60 in the Southern Region. Approximately 75% of surgeons are located where 40% of the population resides, reflecting problems of distribution and access.[64] Ecuador shows significant progress. Between 2000 and 2017, the rate of specialist medical doctors increased from 4 to 10.3 per 100,000 inhabitants, although 50% of specialists are concentrated in Quito, Guayaquil and Cuenca, leaving a disparate distribution in the rest of the country. The specialties of gynecology, pediatrics and family and community medicine account for 30% of the increase in specialist medical doctors.[65]

Education of healthcare workers in Latin America and the Caribbean is heterogeneous

There are efforts to improve medical education in the region. Medical schools are working to increase the number of students, improve the quality of their programs and their research capacity. Similarly, a significant number of medical schools have begun to prioritize specific topics, such as interdisciplinary education, primary care and public health. This indicates that schools are seeking to establish congruence between educational programs and attention to health needs, which is now interpreted as social responsibility.[66]

The number of places for medical students is gradually growing, but schools face resource constraints. A survey conducted by the OECD and IDB in 21 countries in Latin America and the Caribbean identified that 11 countries (Argentina, Belize, Bolivia, Costa Rica, Honduras, Jamaica, Mexico, Panama, Paraguay, Peru, and Uruguay) increased the number of places for medical students.[67] Brazil has seen significant growth. Between 2010 and 2018, this country increased the number of undergraduate places by 120%, from 16,236 to 37,755.[68] Currently, Brazil has 257 medical schools and faculties, which represents significant progress, although it also highlights the complexity of ensuring quality control of curricula and graduates.[69] Medical schools continue to face the challenge of a lack of resources and infrastructure, with limitations to become certified, to have qualified teachers and for students to have access

to modern educational technology. A study of 105 medical schools in the region identified as priorities the improvement of the articulation of human resources policies with medical education and the need to invest more in educational resources.[70]

The education of nurses is variable in the region. A study of 246 nursing schools in 25 countries in Latin America and the Caribbean reported that students are taught mainly in hospital centers and - to a much lesser extent - in primary care clinics. Teachers with postgraduate education are scarce in nursing schools, limiting learning opportunities. Two out of three nursing schools (64%) have adequate facilities, but their capacity to access digital technology is low. Most schools adhere to the guidelines proposed by the American Association of Colleges of Nursing, although interprofessional education is not encouraged, and the job market for nurses is primarily hospital-based: less than 4% work in primary care settings.[71]

Postgraduate education is diverse in Latin America and the Caribbean. There are differences in the number of medical specialties and residencies. In some countries, residency positions are not linked to a planned system to support policies, while in others there is a progressive reordering. In Chile, the government implemented a plan of specialization programs to overcome the deficit of specialists and, in addition to the training period, the specialist medical doctor who received a government scholarship must perform a mandatory period of care in public health centers.[72] In Mexico, one out of every five applicants is admitted to medical and surgical residency programs. Each year there are more than 35,000 applicants.[73]

Nurses have less access to postgraduate programs. In the region, only 10 out of 33 countries offer doctoral programs, and 75% of these are in Brazil. Nurses with doctorates can assume teaching roles and leadership positions in research, teaching, health policy and service provision.[74]

Ongoing training is essential to close educational gaps, but access is limited. Continuous training ensures that medical doctors and other HCWs are up to date in their knowledge, which reduces the margin for error and improves quality. However, continuous learning is not a priority for many countries, and the importance of HCWs having up-to-date knowledge for their daily practice has not been appreciated. In Latin America and the Caribbean, 10 countries have a formal system of continuing medical education: Belize, Bolivia, Costa Rica, Ecuador, Guyana, Honduras, Jamaica, Mexico, Panama and Paraguay, but it is mandatory in only five (Belize, Guyana, Jamaica, Panama and Paraguay).[75] These results indicate that

significant policy and program efforts are required to close the health workforce gaps in terms of numbers, but also in terms of the competencies they will require in the coming decades.

There are multiple barriers to professional updating. The lack of opportunities puts HCWs at a serious disadvantage, as they are either not accustomed to or do not have access to continuing education. Lack of resources for continuing education, including funding, infrastructure and technology for seminars, workshops and virtual or in-person training programs, prevents the implementation of regular, comprehensive programs.[76] HCWs working in remote communities face barriers to accessing continuing education programs. Addressing these challenges requires a multifaceted approach that involves greater investment in financial, physical and human resources, and requires collaboration between the government, academic institutions, medical associations and the health systems themselves to prioritize continuing education as a mechanism to improve the quality of services.

The capacity to use digital technology for education is diverse. It is foreseeable that digital technology will become the primary mechanism for education in the coming years. HCWs not accustomed to using digital technology (digital migrants) will need to acquire these skills. In contrast, new generations of students (digital natives) naturally understand and use technology as a learning platform and are accustomed to using multiple devices to communicate, generate, retrieve, analyze and share information. Digital training programs should consider strategies to bridge this digital divide.

Shortage of teachers. The shortage of teachers is an additional problem, due to the aging of HCWs, which is parallel to that of the general population, so the design of large, interactive and online courses would allow access to training for HCWs, but with a lower requirement for teachers.

Changes in medical care. HCWs must provide care in a variety of circumstances. The provision of health services is changing, depending on the multiplicity of care sites, from the home to highly specialized hospitals, to other sites such as community centers, primary care clinics, basic hospitals or temporary hospitals. HCWs must be trained to care for diverse populations with different cultures and perceptions of health, illness and death. An essential point to understand is that the user population is the focus of attention of health systems and healthcare services and that their rights must be guaranteed. Moreover, the problems of care are varied and complex, generally in an environment of scarce resources and excess demand.

The COVID-19 pandemic had a disruptive effect on undergraduate and graduate medical education. Argentina, Bolivia, Costa Rica, Chile, Dominican Republic, Ecuador, Mexico, Panama, Peru, and the Dominican Republic documented the actions of medical schools and faculties to reduce the disruption caused by the pandemic in academic activities and support the response to the public emergency. The disruption of in-person classes, while delayed the advancement of academic programs, also accelerated the introduction of a virtual learning environment. This emergency migration from in-person to virtual learning signaled the urgency to push for reforms aimed at modernizing medical education.[77] The support of medical and nursing students on the front lines of the pandemic response was viewed as a positive learning experience that contributed to confront the health emergency, although the risks and consequences were recognized, primarily in terms of stress, risk of infection, and the need for emotional support.[78]

Older adults need healthcare workers with specific competences

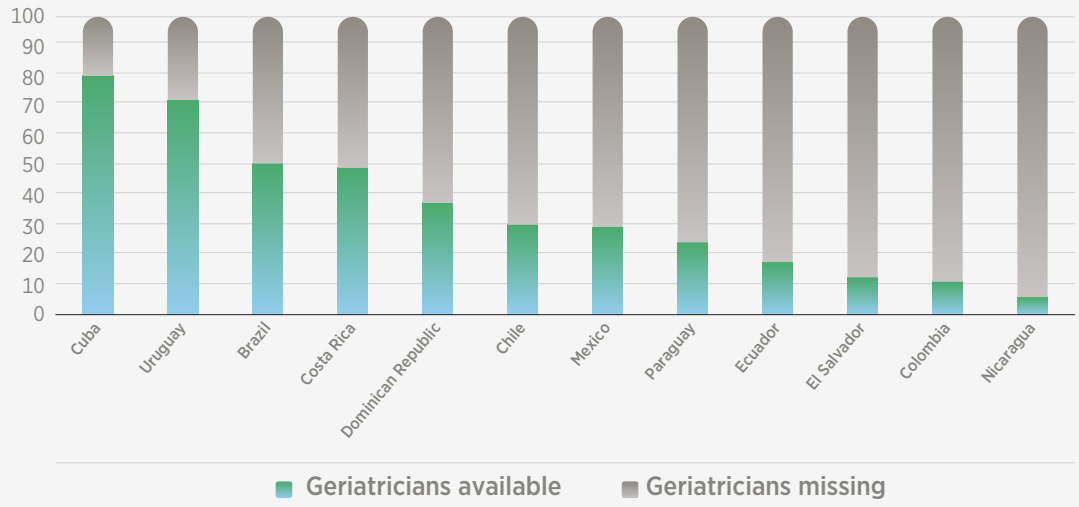
Specialists in geriatrics, psychogeriatrics or geriatric nurses are scarce. These HCWs are indispensable because, in addition to treating complex cases, they are key to the education and training of non-specialized HCWs who also care for older adults. Chart 2.5 illustrates the availability of geriatricians and the deficit to be covered considering the criterion of 1 per 5,000 adults over 65 years of age in 14 countries of the region, including Brazil, Belize, Canada, Costa Rica, Dominican Republic, El Salvador and Nicaragua. Estimates indicate that this gap will widen due to the speed of the increase in the proportion of older adults and the slow pace of training of HCWs in this field.[79]

In addition, the number and distribution of HCWs caring for older adults is unknown. The type of HCWs caring for older adults depends on the type and availability of health and social services, the context of the health and social services system, and the educational offering of each country. The scarcity of information limits decision making for the education, training, recruitment and retention of HCWs responsible for caring for older adults. During their professional or technical training, HCWs have little training in geriatric and gerontological issues, and those who care for older adults in their daily work face limitations in their competencies.[80] The limitations do not go unnoticed by users, who report poor quality.[81]

The region has alternatives for training HCWs to care for the elderly. In practice, due to the fact that a large number of HCWs care for older adults, continuing education and training programs for specialized HCWs are in operation to improve competencies. Argentina, Brazil, Chile, Cuba, Mexico and Uruguay have training programs aimed at HCWs, volunteers and informal caregivers; however, there is no evidence available on the relationship between the number of training resources and the number of HCWs required to care for the elderly or on improvements in the quality of care.[82,83] In Colombia, the Latin American Academy of Medicine of the Elderly provides refresher courses in 20 countries of the region to increase the geriatric competencies of HCWs. In Mexico, the National Institute of Geriatrics offers in-person and online education and training to expand the competencies of HCWs caring for older adults. The growing body of knowledge on geriatric and gerontological issues is creating conditions for those who care for older adults to work in an environment of articulated, evidence-based health and social services. The dimension of these efforts needs to be analyzed to determine to what extent it will be necessary to promote greater educational opportunities to have a critical mass of HCWs with indispensable skills to care for older adults.

CHART 2.6

AVAILABILITY AND SHORTAGE OF GERIATRICIANS IN LATIN AMERICA AND THE CARIBBEAN



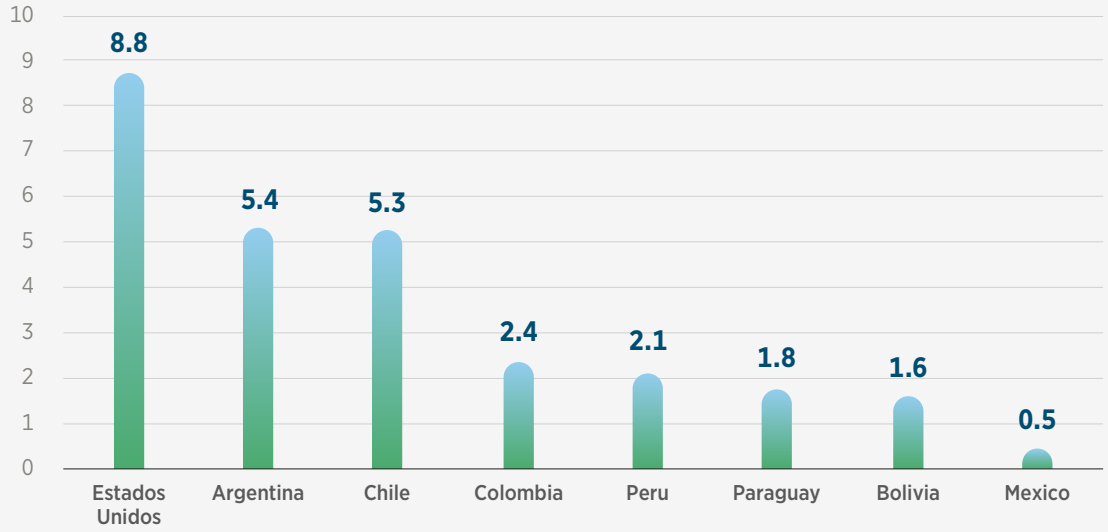
Source: Own elaboration with data from the Ministries of Health and geriatricians' associations of the countries included in the graph.
Note: Ratio of geriatricians per 5,000 adults over age 65 is shown.

COVID-19 made the precariousness of healthcare workers more visible

The health crisis has highlighted the limitations of healthcare workers specialized in critical care. In Latin America and the Caribbean, there is a shortage of medical doctors and nurses specialized in intensive care, pulmonologists, anesthesiologists, cardiologists and other disciplines to care for critically ill patients. In general terms, one specialized nurse is required for every two intensive care beds and one specialist medical doctor for every six beds. The numbers of intensive care specialists illustrate the shortage of these health HCWs in the region. In the United States there are 8.8 intensive care specialists per 100,000 inhabitants;[84] Argentina and Chile have 5.4 and 5.3, respectively,[85] while Mexico has 0.5 specialists[86] (Chart 2.5). Unfortunately, the number of intensive care nurses in the region is unknown.

CHART 2.7

MEDICAL DOCTORS SPECIALIZING IN INTENSIVE CARE PER 100,000 INHABITANTS



Source: Own elaboration based on data from the Society of Critical Care Medicine, Torres (2020) and Heinze-Martin et al. (2018).

The mental health of HCWs must be a priority during public health emergencies. HCWs faced difficult decisions to prioritize the care of severely ill COVID-19 patients in an environment of increasing scarcity of resources and complex ethical standards and protocols of care. The Pan American Health Organization (PAHO) and the COVID-19 HCWs Study (HEROES)[87] in 11 countries (Argentina, Venezuela, Brazil, Chile, Colombia, Guatemala, Mexico, Peru, Bolivia, Puerto Rico and Uruguay) indicate that between 14.7% and 22% of HCWs developed depressive episodes, and between 3% and 15% developed major depressive episodes. Similarly, between 5% and 15% developed suicidal ideation. However, only 11-25% received psychological support. Several studies reported that the HCWs manifested symptoms of post-traumatic stress disorder and depression. In Chile, 65% of HCWs reported depression, 74% anxiety, 65% insomnia and 57% stress.[88] In Peru, 70% of HCWs suffered from stress and other psychological disturbances.[89] The impact on mental health was exacerbated by the need to cope with the subsequent waves of COVID-19, as HCWs were fatigued and suffered physical and mental exhaustion.

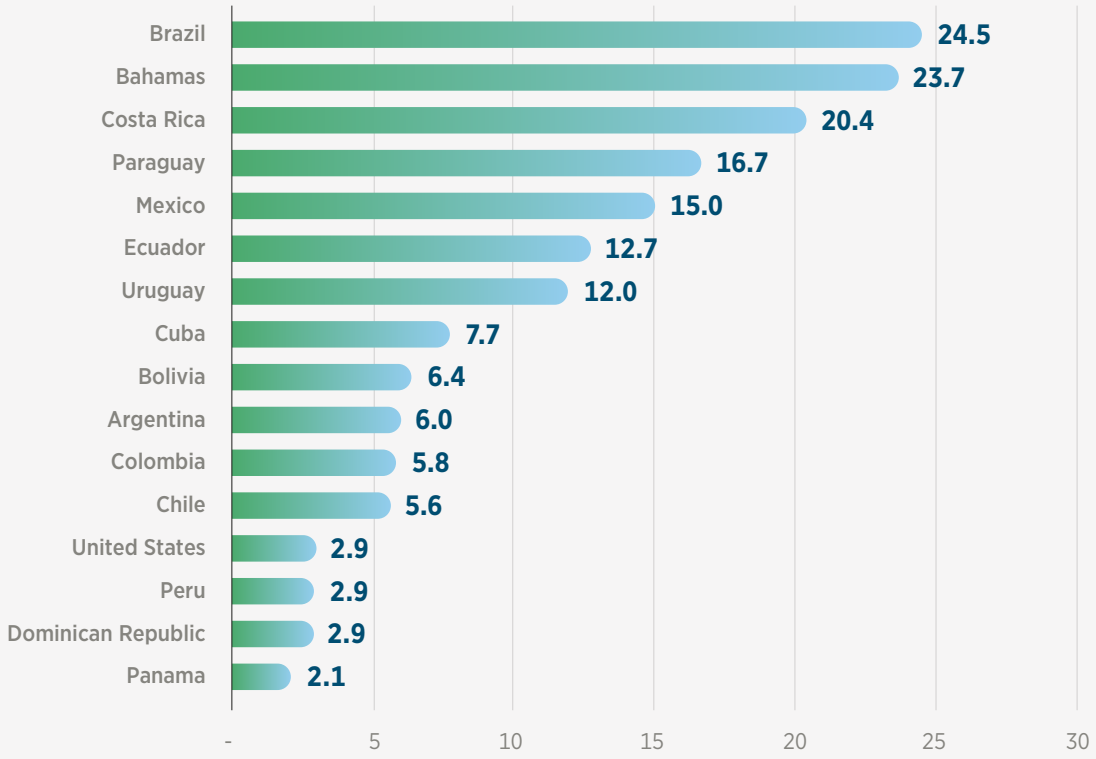
Healthcare workers received mental healthcare in some countries. PAHO issued technical recommendations[90] and the Ministries of Health of some countries implemented strategies to address the mental health of HCWs. In general, support measures to reduce anxiety and fear were related to working conditions, risk reduction and support to address personal and family needs.[91] For example, Mexico[92] and Colombia[93] issued recommendations to address mental health, identify warning signs and designated areas with specialized HCWs. In a similar effort, clinical psychologists from universities in Argentina, Spain, the United States and Mexico implemented the Personal Salud COVID-19 internet portal to provide free support and guidance in the area of mental health to HCWs in Latin America.

The pandemic made the occupational hazards of healthcare workers more visible. The daily activities performed by HCWs expose them to various health risk factors such as chemical and biological agents and radiation. Harassment and violence by HCWs themselves, users and their families have also been described. The care of patients with COVID-19 multiplied the risk factors for infection, among which the following should be mentioned: (i) inadequate and insufficient infection control measures; (ii) lack of knowledge of the correct way to use personal protective equipment; (iii) lack of knowledge of protocols for the care of infected patients;[94] (iv) work in high-risk areas, such as emergency departments, operating rooms, intensive care units, and clinical laboratories; (v) long working hours in which the HCWs were in direct, continuous and prolonged contact with patients and laboratory samples;[95] and (vi) pre-existing conditions of the HCWs, such as chronic diseases or other factors such as age over 65 years, which increased the risk of serious complications and death in the event of contracting COVID-19. This last aspect is relevant, as HCWs suffer from chronic diseases in a higher proportion than the general population.[96,97]

The proportion of infected healthcare workers indicates the effectiveness of protective measures. The proportion of infected HCWs makes it possible to assume the extent to which measures were implemented to provide safety and reduce occupational risks. The availability of personal protective equipment or the competencies of HCWs for the safe handling of COVID-19 cases were critical elements. More specialized HCWs with experience in handling critically ill and infectious patients had twice the risk of infection as inexperienced HCWs. In 2020, the countries reporting the highest proportion of HCWs infected with COVID-19 were Brazil (24.5%), Bahamas (23.7%), and Costa Rica (20.4%), as shown in Chart 2.8.

CHART 2.8

HEALTHCARE WORKERS INFECTED WITH COVID-19 (PERCENTAGE)

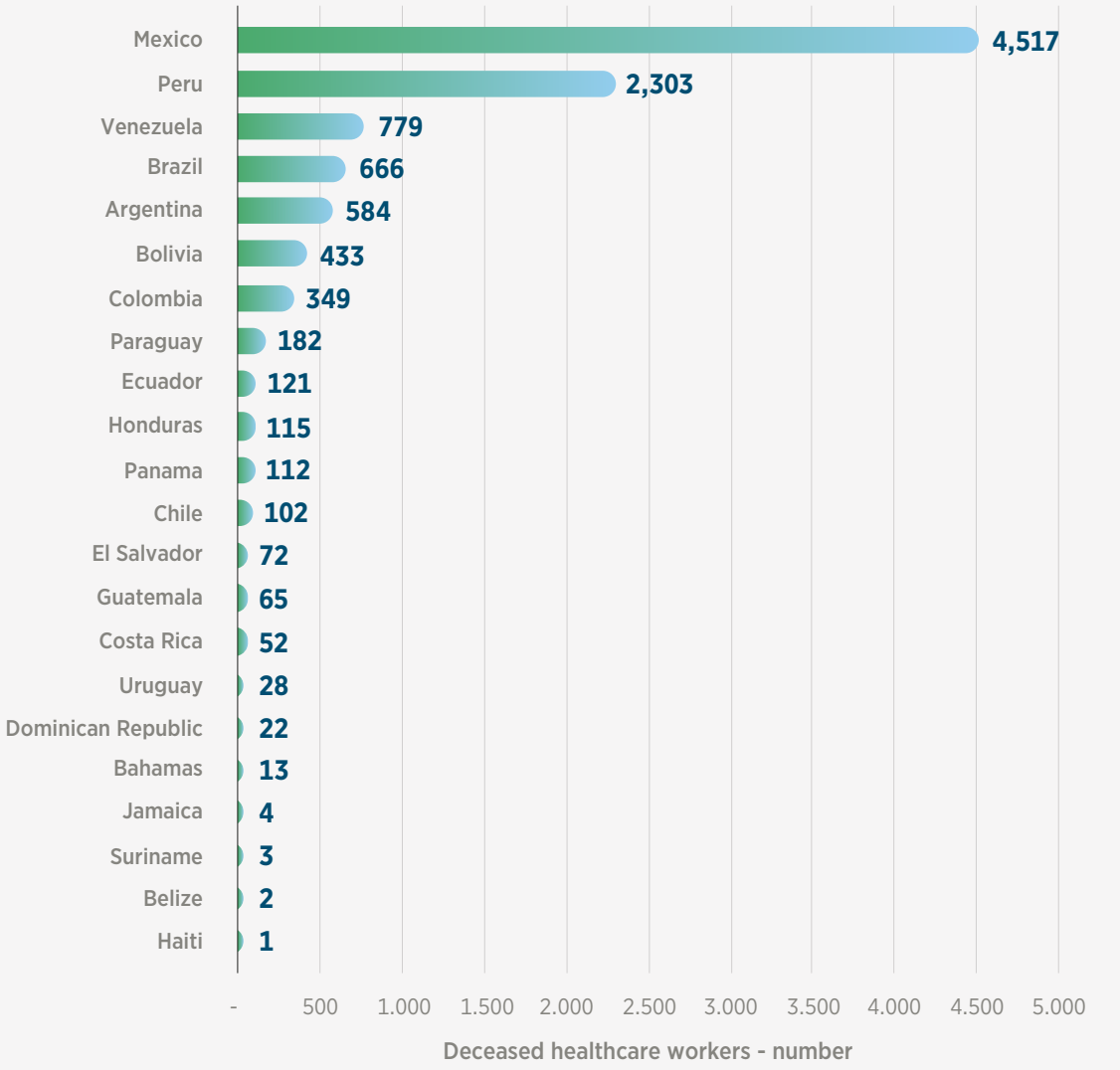


Source: Own elaboration based on official data from the Ministries of Health and news articles.

Mortality due to COVID-19 among HCWs in Latin America and the Caribbean made the magnitude of the risk visible. Mexico and Peru reported the highest number of deaths recorded up to October 2021 (Chart 2.9). However, the figures should be interpreted with caution, as there are different determining factors, such as the local context of each country, the density of human resources, the reliability and timeliness of the data, and the circumstances of the death or of the infection itself (whether it occurred in clinical areas or in the community). Countries stopped officially reporting HCWS deaths during the last quarter of 2021.

CHART 2.9

CUMULATIVE HEALTHCARE WORKERS DEATHS (2020-2022)



Source: Pan American Health Organization (2021), except for Argentina (Ministry of Health), Mexico (Ministry of Health) and Peru (Ministry of Health).

Health services implemented actions to deal with the emergency, address the shortage and mitigate the vulnerability of healthcare workers. The main dilemma for health services was to assign HCWs to attend COVID-19 cases without neglecting the care of other patients. Specialized HCWs were prioritized for COVID-19 cases and additional HCWs were hired on an interim basis to mitigate shortages.[98] Brazil brought in 970,000 students and HCWs through the O Brasil Conta Comigo initiative.[99] Argentina hired 15,200 HCWs. The Rapid Assessment of Service Delivery for Noncommunicable Diseases during the COVID-19[100] epidemic in 28 countries reported that most of these countries reassigned HCWs who usually care for patients with chronic diseases to care for COVID-19 cases. Jamaica, Mexico and Peru received support from Cuban doctors and nurses. Colombia authorized the work of foreign HCWs as part of the response.

NCDs present multiple challenges for the healthcare workforce

Chronic diseases require prevention, detection and medical care throughout their course. HCWs face challenges related to availability, competencies, education, scarcity of resources (drugs, equipment, infrastructure) and obsolete care models that do not facilitate continuous and coordinated care throughout the course of the disease. A fundamental factor in the delay in patient care is the lack of HCWs. The available HCWs, due to work overload, must multiply their time and tasks to meet the demand, not necessarily satisfy it.

It is essential to align worker competencies with the needs of patients with NCDs. The lack of congruence of worker competencies with the needs of the patient, the limited ability to work as a team, the persistence of a technical approach and omission of the patient's cultural and social context, and care without continuity or coordination are limitations that must be overcome.

Education and training of healthcare workers to care for patients with NCDs needs improvement. HCWs require more training and resources to care for patients with NCDs.[101,102] Cardiovascular disease care, the leading cause of death in Latin America and the Caribbean, illustrates the need to increase the number and skills of HCWs. The IDB financed a study in 527 hospitals in Mexico to analyze the supply and demand for acute myocardial infarction (AMI) services. Thus, hospital capacity to diagnose AMI and to perform pharmacological and mechanical reperfusion to treat patients was studied. The limitations were tangible.

Among the second-level hospitals, only 16% were certified by the Mexican General Health Council, only 37% were competent to diagnose AMI, 8.7% to perform pharmacological reperfusion, and only 2.8% to perform mechanical reperfusion. As for third level hospitals, only 12% were certified, 51% were competent to diagnose AMI, 26% to perform pharmacological reperfusion and 18% to perform mechanical reperfusion. It is desirable that the majority of second and third level hospitals have the competencies to care for patients with AMI.[103] The risk of complications and death increases significantly when the patient with myocardial infarction is not diagnosed and does not receive the required treatment in a timely manner.[104]

Cancer care in Latin America and the Caribbean faces a similar situation due to the shortage of oncologists. For example, the United States has 1 oncologist for every 137 new cancer cases, while Panama has 1 for every 540 cases and Chile has 1 for every 667 new cases.[105] The unequal distribution of qualified HCWs has negative consequences. Analysis of the supply of pediatric cancer services in 98 hospitals in Mexico identified asymmetries in the distribution of pediatric oncologists. In the central states (Mexico City, State of Mexico and Morelos) there were 1.4 pediatric oncologists per 100,000 children aged 0-18 years. In contrast, in the southern states, such as Campeche, Chiapas, Guerrero, Oaxaca, Tabasco, Quintana Roo and Yucatan, the same rate is 0.4 pediatric oncologists. This asymmetry translates into lower survival of children with leukemia in the south of Mexico compared to those regions with more oncology HCWs.[106]

The usual model of medical care influences the shortage of healthcare workers to care for patients with NCDs. Routine care consists of the interaction between a medical doctor and the patient, without much participation of the health team essential to treat chronic patients. This limitation occurs because health services are not designed to care for this type of patient. The staffing of primary care and community service clinics lacks or has a shortage of HCWs who should be involved in the care of patients with NCDs. Nutritionists, social workers, nurse specialists, rehabilitation technicians and specialists, psychologists, among other medical disciplines and specialties, are in short supply in primary care services. A study in Mexico identified that, in order to care for patients with diabetes, it would be necessary to increase the number of medical doctors by 1.2 times, nutritionists by 4.2 times and social workers by 4.1 times to meet the demand and provide the necessary services.[107]

Lack of competencies impoverishes the quality of care and reduces the likelihood of achieving better health outcomes for patients. Competent care is essential in the management of patients with NCDs. The Institute of Clinical and Health Effectiveness of Argentina identified that the HCWs of the REDES Program caring for patients with diabetes and hy-

pertension in primary care clinics lacked the necessary skills to care for these conditions, overestimated their skills and had a positive bias with respect to their personal experience in achieving favorable outcomes.[108] Clinical practice guidelines are a useful tool for medical care; however, 45% of the HCWs do not know about them and do not use them, stating that this is due to lack of training and poor applicability.[109] Mexico implemented an information system that measures a quality of care index for diabetes. It is a system fed by 11,361 clinics nationwide. On a scale of 0 to 100 points, the national performance is 65.1. This is due to the fact that only half of the patients attend their consultation regularly, and 48.7% have achieved metabolic control.[110] These figures point to the need for interventions to improve the quality of care.

Technology is an effective tool for improving healthcare

Technological innovations are transforming the provision of and demand for healthcare services. Technological innovations include devices, medical and surgical equipment, drugs, vaccines and digital information systems. Technology also encompasses a wide range of tools, such as the design of clinical protocols. In clinical care, information technologies are useful tools for sharing information, eliminating redundant paperwork, and monitoring patients and providing services remotely. The convergence of decision support and clinical information systems, such as the electronic health records, can improve the adherence of HCWs to treatment guidelines, reduce work overload, and improve service efficiency by avoiding duplication of services and patient interviews to collect information that could be easily accessible in electronic records. It also facilitates continuity of treatment for patients, as medical doctors can more easily view medical records.

NCDs are of interest in the development and implementation of digital technology-based solutions. This growth is due, in part, to the desire to overcome the shortage of human resources and the limitations of access to healthcare. These include health education to promote NCD screening in patients and smartphone-enabled medication adherence tools for asthma and diabetes management, which have demonstrated benefits in clinical trials.[111]

Technology has shown multiple benefits. Technology is transforming the education, training, competencies, and tasks of HCWs.[112] Moreover, it strengthens medical and surgical care,

increases quality and patient safety[113,114] and facilitates the collection, analysis, and use of information for management and administration of, and attention to health.[115,116,117]

The generation of new technologies is faster than the capacity of health systems to adopt them. Public health systems have difficulties in obtaining adequate investment to adopt, adapt and institutionalize new technologies, while some segments of the private sector in many countries manage to invest rapidly. In the public sector, a substantial investment of resources is needed to acquire new technologies in an environment of scarce resources, capabilities and infrastructure that would hinder the creation of long-term sustainable programs. In this sense, the evaluation of health technologies is an indispensable element in deciding which technologies can be incorporated, considering their cost-effectiveness.

New technologies present new challenges for healthcare workers

Access to technologies for clinical care is still limited. Healthcare technologies, regardless of their degree of innovation, are not yet accessible to all HCWs. The scarcity of technology not only reduces users' access to diagnosis and treatment, but also reduces opportunities for HCWs to develop their competencies.

- Common technology for the diagnosis and treatment of multiple conditions is scarce and diversely distributed. For example, in Peru, staff working in rural clinics lack technologies for diagnosing common conditions such as malaria, dengue fever, vaginal infections or cervical cancer screening.[118]
- Technology that is commonly used in developed countries is still scarce in Latin America and the Caribbean. This is the case of magnetic resonance equipment, computerized tomography, linear accelerators and mastographs. OECD countries have 27 CT scanners per million inhabitants and the region, on average, has 8.3. There is considerable variability between countries: Chile has 24, Brazil 15.4, Mexico 5, and Nicaragua 0.5. The variability of mastography units per million women between 50 and 69 years of age is even greater. Thus, Panama has 278, which is higher than the average for OECD countries (176.7), the average for Latin America and the Caribbean (110.4) and Paraguay (7.3).[119]
- Access to sophisticated technologies is more difficult. One example is robotic surgery. The existence of robotic equipment per million inhabitants varies widely. Chile has 1 robot for

every 2.1 million inhabitants; Uruguay has 1 for every 3.4 million; Brazil has 1 for every 5.1 million; and Argentina has 1 for every 14.6 million. For reference, the United States has 1 for every 110,000 inhabitants and the European Union has 1 for every million inhabitants.[120]

- The International Atomic Energy Agency recommends the existence of between five and six radiotherapy teams per million inhabitants. OECD countries have 7, while Latin America and the Caribbean have, on average, 1.4. No country in the region reaches the recommended number. Uruguay has 3.8, while a significant number of countries fail to have one radiotherapy team per million inhabitants, as is the case of Chile, Honduras, Guatemala, Mexico, Ecuador, and the Caribbean countries.[121]

Healthcare workers have limited training opportunities for new technologies. The development of HWCs skills to adopt new technologies is slow due to limited training opportunities. The slow pace is due to the shortage of medical technology and minimal public sector investment. There is an unmet need to develop HCWs competencies in digital health. In terms of capacity building, the widespread deficit of digital skills is one of the most important issues in Latin America.

The proportion of medical doctors using computers is low in Latin America and the Caribbean. A 2018 OECD survey on the characteristics of healthcare systems identified the level of computer use by primary care medical doctors in 19 countries in Latin America and the Caribbean.[122] The study found that in Argentina, Belize, Bolivia, Chile, Colombia, Costa Rica, Ecuador, Panama and Uruguay, more than 75% of medical doctors use computers for medical care. However, the study highlighted the heterogeneity of the use of health information technology. Thus, computers are predominantly used for elementary functions such as appointment scheduling and recording medical notes. More complex functions, such as alerting HCWs of potential drug interactions or sending prescriptions to the pharmacy, are rare. The data in this report also show that in Guatemala, Guyana, Honduras, Jamaica, Mexico, Paraguay, Peru, Dominican Republic, El Salvador, and Trinidad and Tobago, less than 75% of medical doctors use computers in their daily work, indicating a significant lag in the adoption of digital information technology (Table 2.1).

TABLE 2.1

USE OF COMPUTER EQUIPMENT BY MEDICAL DOCTORS IN LATIN AMERICAN COUNTRIES

COMPUTER USE BY PRIMARY CARE MEDICAL DOCTORS	Argentina	Belize	Bolivia	Chile	Colombia	Costa Rica	Ecuador	Panamá	Uruguay
75% use computers	✓	✓	✓	✓	✓	✓	✓	✓	✓
Schedule medical appointments			✓	✓		✓		✓	✓
Request laboratory studies		✓		✓		✓	✓		✓
Prescribing medications		✓		✓		✓			✓
Record medical notes		✓	✓	✓	✓	✓	✓	✓	✓
Refer patients to specialists	✓	✓	✓	✓		✓			
Save results of diagnostic studies	✓		✓	✓		✓			✓
Receive drug interaction alerts	✓	✓				✓	✓		
Send prescriptions to the pharmacy		✓		✓		✓	✓	✓	

Source: prepared with data from the OECD: Health Committee Survey on Health Systems Characteristics. Round 2018.

The introduction of digital information systems presents practical problems. In countries where the electronic medical record has been implemented, training of health HCWs has been a challenge to be addressed. The IDB funded the study *Skills, perceptions and use of time of healthcare workers in the Peruvian health sector*, which explored the perceptions of HCWs about their IT-related skills and the skills they will require in the future. The study was conducted in 54 primary care clinics and 2 hospitals. Using a scale of 1 to 5, where 1 meant "no competence" and 5 meant "expert," HCWs self-identified as having intermediate competencies for basic computer literacy and competencies below 2.5 for handling digital technology.[123]

TABLE 2.2

HEALTHCARE WORKERS' SELF-PERCEPTION TO USE NEW TECHNOLOGIES

	Medical doctors N=72	Nurses N=69	Midwives N=68	Directors N=57	Total
	Scale 1-5, where 1 = no competence and 5 = expert				
Basic computer skills	3.6	3.1	3.3	3.3	3.3
Patient identification and registration	2.4	2.5	2.8	2.8	2.6
Electronic medical records	2.1	1.9	3.3	2.5	2.4
Data protection mechanisms	2.2	2.4	2.5	2.5	2.4
Clinical decision support	2.2	1.9	2.0	2.9	2.2
Telemedicine 2	2.3	2.0	2.5	3.0	2.4
Communication with peers	3.4	3.6	3.7	3.6	3.6
Electronic devices for clinical monitoring	1.9	2.1	2.2	2.2	2.1
Medication and prescription management	1.7	1.8	1.5	2.2	1.8
Management of laboratory and imaging studies	2.1	1.9	1.6	2.9	2.1

Source: Garcia (2019).

3

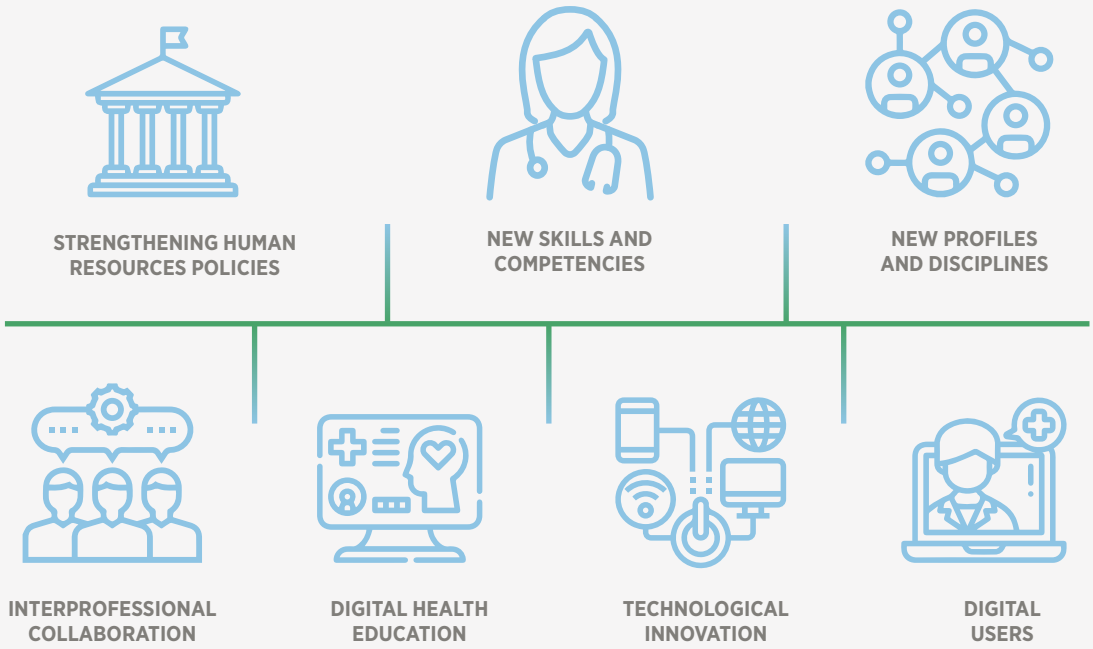
Innovations in the field of healthcare workers

Innovations occur simultaneously in different ways

What is innovation in health? Health innovation is the introduction of a new concept, service, process or product to improve healthcare, education or research. The objectives of innovation are to improve the quality, safety and efficiency of services, and to maintain or improve the health status of the population.[124] Innovations are visible in the different areas related to HCWs and range from strengthening human resources policies, to the acquisition of new skills and competencies, the emergence of new profiles and disciplines, greater interprofessional collaboration, changes in the training of HCWs and the digitalization of care and interaction between users and health HCWs (Chart 3.1).

CHART 3.1

INNOVATIONS IN HEALTHCARE WORKERS



Source: Own elaboration.

Health workforce policies are advancing

Education and planning policies are aligned to improve availability and competencies. In Latin America and the Caribbean, policies and regulations on education, planning, recruitment, training, working conditions and distribution of HCWs are gradually advancing.[125,126] Actions to address the deficit in the number, distribution and competencies of HCWs are tangible. Countries have varying degrees of up-to-date information on the number, position and location of HCWs.[127] This information makes it possible to generate policies aimed at improving the availability of HCWs. Some examples are highlighted below.

- Argentina created the Federal Observatory of Human Resources in Health whose objectives are to contribute to the development of policy leadership and management capacity, strengthen the monitoring and evaluation of HCWs and develop the capacities of human resources management units throughout the country.
- Brazil implemented the Mais Medicos Program (PMM), which informs efforts to increase the number of HCWs. This program seeks to increase medical doctors from 1.8 to 2.7 per 10,000 inhabitants and reduce disparities in their distribution. The PMM has three basic strategies: (i) increasing the number of places for medical students and new medical courses; (ii) investment in reconstruction of primary care units; and (iii) recruitment of Brazilian and foreign medical doctors. The PMM prioritizes localities with a shortage of primary care medical doctors.[128]
- In Chile, the Gap Closing Plan has made it possible to identify and plan actions to reduce the shortage of general practitioners and specialists.[129]
- Colombia published in 2018 the National Policy on Human Talent in Health 2020-2030, which establishes strategies and lines of action to articulate the processes of training, research, innovation, exercise and performance of human talent in health.
- Mexico has a portal of the Information System of the Ministry of Health, where it is possible to access information on HCWs working in public institutions. This country also has the Administrative Information System on Human Resources in Nursing (SIARHE), which has been collecting periodic information on sociodemographic, educational and labor characteristics of the country's nurses for more than a decade.
- Peru formulated the Human Resources for Health Policy Guidelines and implemented the INFORHUS Information System in 2018. This country implemented strategies to increase the availability of primary care HCWs. Efforts have focused on improving their hiring policies, recruitment, retention and retention mechanisms. Peru is also implementing

methodologies to close the worker gaps between the three levels of care and defining competency profiles for health services managers.[130,131]

- El Salvador developed the Management and Development of Human Talent in Health Plan 2019- 2023 to consolidate the steering role, expand public investment and promote the distribution and retention of the health workforce.[132]

The PAHO/WHO has contributed to improving the governance of human resources in the region. This organization has promoted the Human Resources for Health Strategy for Universal Health Access and Universal Health Coverage, which supports the design of national policies to improve the availability, accessibility, relevance and competencies of the health workforce. This strategy also supports countries in achieving the 2030 Agenda Sustainable Development Goals.[133]

In addition, the PAHO/WHO created the Regional Observatory on Human Resources for Health[134] with a repository of publications.[135] To date, 18 countries in the region have contributed more than 900 publications on different topics related to the health workforce, such as technical guides, policies, training programs, education, primary healthcare and universal health coverage.[136,137]

In March 2020, the PAHO/WHO launched the Monitoring System for the Human Resources in Health Action Plan for Universal Access to Health and Universal Health Coverage 2018-2023. This effort follows up on the Regional Strategy on health workforce policies that countries made as a commitment in 2017.

The action plan has three strategic lines:

1. Strengthen and consolidate the governance and stewardship of HCWs;
2. Develop conditions and capabilities in HCWs that favor access and health coverage with equity and quality.
3. Coordinate with the education sector to respond to the needs of health systems towards universal access to healthcare and universal health coverage.

The plan is consistent with the health workforce governance frameworks[138] that identify strategic actions to ensure sufficient and competent human resources.[139]

The COVID-19 pandemic prompted changes in the working and contractual conditions of healthcare workers. The pandemic prompted significant improvements in working conditions

for HCWs to attract, retain, protect, and recognize HCWs in a context of crisis, which, while positive, also highlights the previous devaluation of HCWs in many countries. Furthermore, most of these contracts were of a temporary nature and have lost their validity as the pandemic has begun to decline, creating an unfavorable environment for the incorporation of HCWs into the health system in the medium and long term. Table 3.1 illustrates some of the changes in planning, inclusion of undergraduate students, in-service training, changes in contractual conditions, support and inclusion of foreign HCWs that were implemented in Argentina,[140] Chile, Brazil, Colombia, Peru, Ecuador and Uruguay.[141]

TABLE 3.1

CHANGES IN WORKING AND CONTRACTUAL CONDITIONS FOR HEALTHCARE WORKERS DURING 2020 IN RESPONSE TO THE COVID-19 PANDEMIC

ACTIONS	ARGENTINA	CHILE	BRAZIL	COLOMBIA	ECUADOR	PERU	URUGUAY
Worker planning	Implementation of human talent management and planning policies. Increase of 15,200 professionals	Evaluation of available personnel and dynamic redistribution in health facilities	Strategic Management System. Contract, activity and payment information through the O Brasil Conta Comigo program	Estimation of staffing gaps for emergencies. Reassignment and expansion of personnel. Relocation of people >60. Progressive approach according to the number of patients	Expansion of the number of health HCWs		
Inclusion of undergraduate students			Inclusion of nurses and medical students	Residents, medical students and professionals in social service		Inclusion of resident medical doctors	
Occupational health	Training program for professionals in charge of the pandemic	Implementation of distance learning platforms	O Brasil Conta Comigo - Profissionais da Saúde Program trained and registered personnel to deal with COVID-19 cases	Voluntary tele-guidance and continuing education. Tele-support and telemedicine	Telemedicine		Training program in COVID wards, mechanical respiratory assistance, long-stay facilities for the elderly. Updating program for all healthcare personnel

ACTIONS	ARGENTINA	CHILE	BRAZIL	COLOMBIA	ECUADOR	PERU	URUGUAY
Occupational health	Incorporation of COVID-19 as an occupational disease Silvio Law - Health Personnel Protection Program	Implementation of personal protection protocols		COVID-19 declared an occupational disease. Death insurance. Biosafety protocol for healthcare personnel - Mental Health			COVID-19 is considered an occupational disease. Health insurance. Additional benefit in case of death. Monitoring of positive cases of healthcare personnel
Recruitment and compensation	Incentive payments and tax exemption for health personnel affected by pandemic care[e]	Establishment of mechanisms for hiring additional personnel	Calls for proposals to increase the number of medical personnel. Payment of bonuses of $667,000 reais for six months	Expansion and reassignment of health HCWs. Temporary financial incentive	Payment of variable remuneration and mechanisms to guarantee job stability[f]	Modification of contractual norms. Expansion of the labor pool. Incentives	
Comprehensive worker support	National Care Plan for HCWs	Social support - child care - mental health program.					
Inclusion of foreign HCWs				Work authorization for foreign health personnel		Qualification of foreign professionals. Cuban Brigades in rural communities	

Source: Own elaboration.

e. ILO Andean Countries. Short-term responses to COVID-19 and persistent challenges in Latin American Health Systems. https://www.ilo.org/wcmsp5/groups/public/---americas/---ro-lima/documents/publication/wcms_768040.pdf.

f. ILO Andean Countries. The Ecuadorian health system and COVID-19. https://www.ilo.org/wcmsp5/groups/public/---americas/---ro-lima/---sro-lima/documents/publication/wcms_799790.pdf.

Tasks are reconfigured and new skills and competencies are required

The tasks of healthcare workers are being reconfigured. Conventional boundaries between different worker disciplines are disappearing. This change is due to the fact that health services are becoming more oriented to:

- Improve efficiency in personnel management and correct the imbalance in its distribution.
- Promote the redefinition of roles to take better advantage of the more diversified talent of the staff.
- Achieve the right supply of the right type and mix of skills and disciplines.

Task substitution or task shifting is a relevant change. Task shifting consists of the transfer of an activity normally performed by a health professional (e.g., a medical doctor) to a health professional with a lower or different level of education and training, or technical staff trained for a specific function. In this sense, the risk of mismatch exists and refers to the HCWs' skills being inadequate with respect to the requirements of their job, either being overqualified or lacking the necessary skills to perform the tasks to which they were assigned. In OECD countries, it was identified that 79% of nurses and 76% of medical doctors perform tasks for which they are overqualified, and it was also reported that 51% of medical doctors and 46% of nurses did not consider themselves to have the required skills.[142]

Task shifting is a response to the context of services and patients. The shortage of HCWs and the increasing complexity of healthcare triggered management transformations to increase efficiency, increase availability and favor the combination of competencies. The expected result is a better response to the demands and needs of users. Task shifting began in 2008 among HCWs caring for patients with human immunodeficiency virus and also among HCWs focused on maternal and child care. NCDs have accelerated the progress of task shifting.[143] Currently, nurses, technical staff and community HCWs detect and treat patients with asthma, cancer, cardiovascular disease, hypertension, diabetes, epilepsy and mental illnesses, such as depression and anxiety.[144]

The conditions of health systems in Latin America and the Caribbean are favorable for task shifting. Primary and community care services have a significant number of nurses and health technicians. Primary care technical assistants in Costa Rica, health technicians in Nicaragua or nursing assistants in Mexico's IMSS-Bienestar Program have been in operation

for decades; however, the activities performed by these HCWs have evolved marginally. Different evaluations point to their limitations and stagnation, which indicates that there is still room for improvement to maximize their performance through the strategy of task shifting.[145,146]

However, task shifting faces obstacles. There are several factors that make task shifting difficult:

- The ratio of nurses to medical doctors is very low in the region. The countries with the most nurses per medical doctor, are Haiti (2.9), Grenada (4.5), St. Lucia (4.9), Dominica (5.8) and St. Vincent and the Grenadines (10.6). At the opposite extreme are Guatemala (0.2), Uruguay (0.4), Venezuela (0.5), Colombia (0.6) and Jamaica (0.6). In contrast, OECD countries have 3 nurses for every medical doctor.[147]
- Rejection of more highly trained HCWs.
- Program discontinuity, unfavorable contractual conditions, frequent turnover, lack of supplies and labor attrition due to an unbalanced workload.
- Rejection by medical associations, which have the political capacity to oppose changes, mainly due to economic interests that create a bias toward technologies and pay scant attention to HCWs and maintenance requirements in the operation of services.
- Slow response from educational institutions, which are slow to change due to financial, organizational and personnel constraints.
- Civil service criteria are difficult to change and may have rigidities that make it impossible to modify job definitions, authorize HCWs to perform certain tasks (e.g., nurses can perform minor surgeries), and adjust salaries in the face of changes in the labor market.

To overcome the obstacles, it is advisable to reengineer health services to institutionalize task shifting. It is also essential to provide non-professional HCWs with favorable contractual conditions, training in new skills, providing them with *ad hoc* care guidelines and protocols, medications, supplies and equipment, and integrating them to work as a team with professional staff. In turn, the professional staff require training and sensitization and incentives to accept and participate in change.

Nurses are the most important source of task shifting. Nurses constitute the largest proportion of the healthcare workforce that has expanded its clinical activities and assumed roles that were once performed only by medical doctors. Nurses now work at the interface of traditional nursing and the medical profession, diagnosing, prescribing and performing

surgical procedures. Their performance is positive, which is reflected in improved quality of care. Patients, in turn, are more satisfied because, unlike medical doctors, nurses provide more information and counseling and spend more time with patients. In addition, nurses have a clinical performance equivalent to that of medical doctors and achieve tangible improvements in patients' health status.[148] Some OECD countries are implementing educational, regulatory and salary reforms to expand and support the new role of nurses, mainly to provide primary care services.[149]

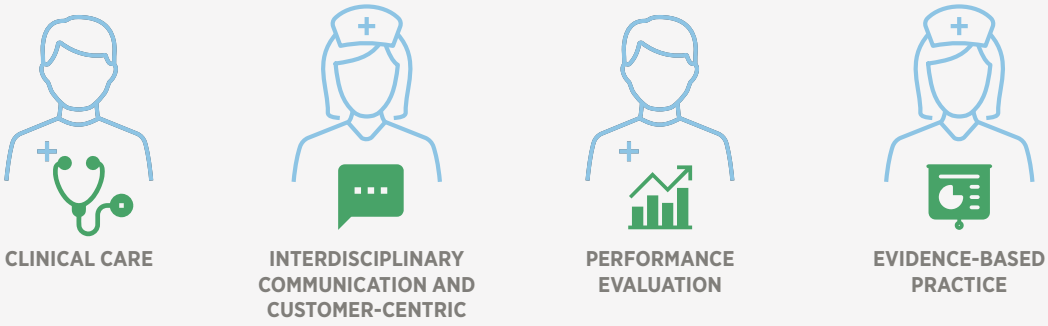
New profiles and disciplines are appearing

The evolution of healthcare services and the digital transformation promote new professional profiles and disciplines. Traditional roles are already insufficient to preserve, recover or improve the health of the population. The advancement of medical knowledge and the diversification of worker functions are influencing change. In addition, technological innovation is transforming healthcare services and motivating HCWs to acquire additional competencies. The following are some examples of the profiles that have been created to improve health services.

Advanced practice nurses represent a significant step in the evolution of the healthcare workforce. Innovations in nursing point toward an expansion of their roles, acquisition of greater managerial skills, practice autonomy and leadership through Advanced Practice Nursing (APN).[150] In the global environment, APNs are at different stages of development, have different roles, activities, definitions and taxonomy according to country context. The scope of practice of APNs is primarily the first level of care, although it is not the only one. In the United States, an increasing number of APNs provide primary care services.[151,152] In Latin America, the competencies of APNs are under construction. A survey in Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Mexico, Nicaragua, Uruguay and El Salvador identified APN core competencies in four domains: (i) clinical care; (ii) interdisciplinary and patient-centered communication; (iii) knowledge of the context of care including public health, management, performance evaluation and quality improvement; and (iv) evidence-based practice[153] (Chart 3.3). Nurses competent in these four domains provide primary care and perform management, leadership, and performance evaluation. APNs also perform case management and coordination functions. These functions consist of assessing health and social needs, collaborating in the design of the management plan, coordinating health and social services, evaluating and improving quality, and maintaining contact with patients and family for communication and self-care education.

CHART 3.2

ADVANCED PRACTICE NURSING COMPETENCIES



Source: Own elaboration.

Health managers. Health managers are oriented toward improving the quality, safety and efficiency of services and, to this end, they must understand the information derived from high quality and economic evaluations in order to design interventions for improvement, reorganize services and adopt new technologies.

Care coordinator. This role articulates and promotes the activities of professional teams in charge of patients or populations. The care coordinator is the response to the fragmentation of medical care and public health. Some of his or her functions include assessing patients' needs, collaborating with the team in the development of management plans, supporting users in accessing the services they need, monitoring the quality of care and maintaining communication with family and caregivers, including making it easier for patients to identify the HCWs responsible for their care.[154,155]

Genetics is promoting the creation of multiple disciplines. Clinical genetics, including counseling, molecular genetics, biochemical genetics and pharmacogenetics, are some of the newest disciplines in this field of health. These specialists have different roles in response to the possibilities arising from genomic sequencing, which is making predictive and personalized medicine feasible. For example, genomic tests identify the predisposition or presence of genetic conditions. In British Columbia, prenatal genetic screening tests for Down syndrome, trisomy 18 and neural tube defects are performed during prenatal care. Other genetic tests are available to identify predisposition to breast cancer and Alzheimer's disease. These tests have the potential to provide information to prevent, treat or delay

the onset of some conditions. HCWs trained in these disciplines are already beginning to provide patient care and collaborate in interdisciplinary teams.

Medical informatics specialists. These specialists are in charge of, among other tasks, developing and implementing health information systems, training HCWs to use information technology and data, improving clinical processes such as triage, diagnosis and treatment planning. The medical informatics specialist also manages and analyzes health services data to monitor and evaluate improvements and ensure that information in electronic medical records and other digital systems is accurate, private and secure.

Inter-professional collaboration on the rise

Inter-professional and interdisciplinary teams enable the advancement of innovative models of care to treat complex conditions. In healthcare, inter-professional collaboration is the active and continuous partnership between professionals with different backgrounds and working with an integrated perspective of patient care and the involvement of technical staff, enabling interdisciplinary collaboration.[g] Inter-professional and interdisciplinary care is a collaborative and complex task for which HCWs require training and socioemotional, technical and digital competencies to work autonomously and collaboratively. The acquisition of these competencies facilitates the introduction of new models of care and makes it easier for health services to work in networks.

The main characteristic of the inter-professional and interdisciplinary team is collaborative work. Collaborative work allows for an understanding of different professional and technical perspectives to guide decision making in the treatment of patients. Teams vary in composition depending on the needs of care. Nurses, medical doctors, pharmacologists, social workers and nutritionists are the disciplines that most frequently make up inter-professional teams. These teams must overcome the overlapping of their different perspectives to address health problems, socialize to facilitate interpersonal relationships, create a sense of unity, promote communication, define the division of roles and tasks, negotiate decision-making and create spaces for interaction and collaboration.[156]

g. Inter-professional teams are made up of university-trained HCWs. Interdisciplinary teams, on the other hand, are comprised of HCWs with university and technical training.

Inter-professional and interdisciplinary teams provide individualized care aimed at meeting complex needs. Older adults are a tangible example. This age group is constantly growing, and their health and social needs are also increasing and varied. Consequently, HCWs from different disciplines must collaborate in a coordinated manner to care for this age group. The interdisciplinary model of care for older adults with cancer follows the disease trajectory from detection and diagnosis to palliative care. This model involves geriatricians, advanced practice nurses, and technical staff.[157] To do so, teams need to work in an articulated network of accessible services in the home, community, social care centers, clinics, and hospitals.[158] Mental healthcare for older adults also requires interdisciplinary attention. Dementia and other mental health problems are on the rise, but the HCWs to care for mental health problems are not growing in parallel either in numbers or in competencies. To compensate for the shortage of professional staff, geriatric mental health technicians are being trained. These new HCWs collaborate in inter-professional teams, use digital technology, and their performance is remarkable.[159,160]

Health and social care workers converge to care for older adults. In order to maintain older adults in the best possible state of health, especially those in a situation of dependency, it is necessary to preserve and improve their autonomy, functionality and quality of life, for which the provision of health and social care services converge. Care with a socio-health perspective requires that both health and social workers from different disciplines work in coordination in inter-professional teams and care networks.

These services improve the physical and mental capacity and maintain or increase the autonomy and functionality of older adults.[161] HCWs caring for older adults should:

1. Be able to understand the physical, mental, cultural, social, and familial aspects of aging.[162]
2. Be competent to assess physical, psychological and nutritional conditions.
3. Treat health problems (frailty, sarcopenia, osteoporosis, osteoarthritis).
4. Timely identify and coordinate medical and social care for complex conditions and mental disorders such as depression, dementia, addictions and social problems such as neglect and abuse.[163]
5. Have communication skills congruent with the values and culture of older adults.[164]

The involvement of new disciplines: the emergence of design thinking in healthcare. Design thinking is already used in education and healthcare provision. It is a formal and useful method for identifying and solving problems in a practical and creative way. More-

over, rather than solving a specific problem, it takes a holistic approach.[165] Design thinking is also interpreted as a systematic innovation process that prioritizes empathy for users' expectations, needs, and challenges to fully understand the problem and develop comprehensive and effective solutions.[166]

In healthcare, design thinking articulates interdisciplinary and user-centered services. The use of design thinking is on the rise in the healthcare field. For example, it was used to create solutions focused on compensating for the intrinsic deterioration of older adults and promoting their autonomy. To solve this problem, designers, engineers, geriatricians and technical staff created devices to prevent falls. The result was encouraging; the new devices improved self-reliance and reduced the number of falls among older adults. In a similar project, integrated care services for older adults with dementia were developed, resulting in the transformation of user-centered services.[167] The examples are not isolated; design thinking has been used to solve problems in the provision of health services, and its applicability and limitations have already been identified in contrast to traditional medical research.[168] In addition, design thinking is gradually being incorporated into the curriculum of educational programs for health professionals[169] and represents a useful tool for promoting interaction between users and HCWs to improve services. Users can and should take a more direct and proactive role in identifying, implementing and evaluating improvements in health services. In this sense, co-design raises the possibility of teamwork between users and HCWs.[170]

NCDs are transforming the competencies of the workforce

Health services are still in transition to address NCDs. The model of care for chronic diseases is the most important reference for reorganizing services and processes of care and for defining essential HCWs. The model integrates interventions for users, services, and the health system.[171,172] Continuity of care and coordination of HCWs are essential to achieve positive outcomes. In patients with cardiovascular disease, implementation of the model has reduced the risk of acute complications and service utilization.[173] Complementarily, new NCD management models are more responsive to the needs of individuals and families, incorporate their perspectives and preferences, and provide educational and psychosocial supports for effective care. Users who participate in informed decision-making achieve better health outcomes.[174]

The care of patients with NCDs requires HCWs to have specific competencies to:

1. **Manage the process of change toward a model for patients with NCDs** to establish new forms of collaboration and ensure coordination, continuity and quality of care.
2. **Provide continuous and coordinated care to patients during all stages of the disease** from detection to recovery or palliative care.
3. **Provide user-centered care.** HCWs require communication skills, the ability to interpret a client's cultural context, provide education and information to patients and caregivers in decision making and self-care. Communication skills are necessary to negotiate, share decisions and solve problems collectively.
4. **Create inter-professional teams** that must work in coordination. Cancer care is the appropriate example. Oncologists, surgical oncologists, clinical pathologists, radiologists, nurses, nutritionists and psycho-oncologists are indispensable to ensure continuity in the diagnosis, treatment and rehabilitation of cancer survivors.
5. **Incorporate new profiles,** such as a case manager or care coordinator. The complexity of chronic conditions requires HCWs capable of guiding both the HCWs themselves and the patients/caregivers so that they receive the required care.

An example of inter-professional diabetes care. Mexico implemented an inter-professional model of care for type 2 diabetes. Mexico has a high prevalence of diabetes (12%) in its adult population. The Mexican Social Security Institute (IMSS) developed the DIABETIMSS program to improve care for 3.8 million patients with diabetes. DIABETIMSS is a coordinated and integrated healthcare model that has three important elements: (i) redesign of care through a health team (medical doctors, nurses, psychologists, dietitians, dentists, and social workers); (ii) decision support systems with evidence-based clinical guidelines; and (iii) counseling and empowerment of patients for self-care. The program in its initial phase served 91,000 patients in 136 DIABETIMSS modules and achieved favorable results, since, in contrast to the traditional model of care, DIABETIMSS increased the number of patients under metabolic control from 24 to 30%.[175] Proper metabolic control lowers the risk of acute complications, reduces the demand for emergency services and hospitalization, and slows down the development of chronic complications. This positive health outcome translates into greater quality of life and functionality, less disability and longer survival.

New perspectives in the training of healthcare workers

The focus in health workforce education is on a comprehensive perspective of individual and population health. The preparation of HCWs to meet the challenges of healthcare is shifting from the traditional curative orientation to a balanced curriculum that incorporates not only biomedical, clinical and public health aspects. Health workforce training encompasses other areas such as demography, sociology, ecology and technological innovation. Studies of future trends in medical education agree on a number of attributes that programs should incorporate:[176,177]

- **Inter-professional education.** This approach consists of educating HCWs from different disciplines to work collaboratively and focus on user-centered care. The inter-professional perspective emphasizes teamwork, communication and shared decision making.[178] In Latin America, inter-professional education in undergraduate nursing is incipient. Only 49% of the countries have standards for inter-professional education in nursing, compared to a global average of 65% and 87% in Europe.[179]
- **Humanistic approach.** Students must understand the medical and ethical complexities of healthcare and learn to communicate with patients and their families. For example, students should have a strong background in topics related to palliative care, thanatology (needs of terminally ill patients and their families), and mental healthcare. The curricula of medical and nursing schools and faculties touch on these topics only tangentially.
- **Cultural competence.** Cultural competence is the ability of HCWs to work effectively with clients from different cultures. It is essential that HCWs understand the importance of providing culturally appropriate services.
- **Respect for diversity.** Students must understand the specific health demands of diverse social groups and be trained to respond appropriately. Older adults, people with disabilities and aspects related to gender perspective and sexual preferences require training in order to be attended from a social and health perspective.
- **Early integration between theory and practice**. Consists of integrating clinical care practices with real patients in the context of preclinical courses, so that students collaborate in the design of strategies to improve services. This type of experience enables students to strengthen practice-based learning and reinforce the notion of patient-centered care and understanding of multidisciplinary care through participation in the continuum of patient care with a healthcare team.

- **Social responsibility.** This approach allows students to understand health problems from a social perspective, to identify and address the needs of the community. Community immersion favors the understanding of the social determinants of health and trains in the search for solutions.
- **Advanced technology-assisted learning.** Technology allows students to use simulators and augmented virtual reality to facilitate learning and understand the consequences of clinical decisions. In addition, technology allows students in schools with limited resources to remotely access courses and training that would not be available locally. In addition, digital technologies have boosted communication with teachers and peers for the exchange of experiences and learning through social networks.
- **Continuous professional development and learning.** Medical schools and faculties prepare students for continuous learning. Newly graduated HCWs should be prepared to provide professional care to the population. It is essential that they have the skills and responsibility to make decisions in uncertain environments and complex situations with a critical and scientific approach. In addition, they must be prepared to collaborate in multi-professional teams as a leader and as a peer; and maintain a culture of creativity, innovation, continuous improvement and global social responsibility.[180]
- **Introduction of innovative technology combined with traditional methods.** Developed countries have introduced a variety of innovative educational techniques such as mobile augmented reality, virtual patients for scenario-based learning, and live labs for contextualized informal learning.[181,182] However, in the educational setting, digital technology faces limitations and it is advisable to combine it with traditional educational methods. Analysis of the performance of digital educational interventions indicates that medical students and residents learn to use the electronic record in an experimental or simulated environment, but their competencies do not include extraction, aggregation, or visualization of clinical data for specific patient panels or populations.[183]

Digital health education is multiplying

New technologies are transforming the education of the healthcare workforce. In the next 20 years, 90% of jobs, including those in the healthcare sector, will require technological and digital competencies.[184] Consequently, healthcare students need to be prepared for the future, not the present. This statement means that, from the training stage, HCWs must be able to respond to, assess the usefulness of, and incorporate new technologies in

healthcare. Regardless of the level of professional development, it is imperative that HCWs have the ability to understand the future work context and maintain an open attitude to acquire new skills and discard obsolete ones. Technical expertise, the habit of continuous learning and the ability to appreciate, adopt and adapt new ways of thinking about healthcare are essential.[185]

Latin America and the Caribbean have multiple initiatives to educate and update HCWs in digital health. Learning interventions based on information and communication technologies allow HCWs to learn anywhere, anytime, and provide opportunities for interactive communication and networking.

Significant efforts have been made by universities and academic centers in Latin America to train HCWs with competencies in digital health. Countries such as Brazil, Peru, Chile and Argentina have implemented educational programs both to train and update HCWs.[186] PAHO has contributed to laying the foundations for digital health training. Some examples are mentioned below.

- The Universitat Oberta de Catalunya, in collaboration with the Ministry of Education of Argentina, launched an international postgraduate program in digital health with support from the IDB. This program provides scholarships to HCWs in Argentina to acquire digital skills, favor the paradigm shift reflected in the empowerment of users in their health and in data-driven decision making.
- Chile's National Center for Health Information Systems (CENS) identified the gaps in the adoption of health information systems and the need for digital health skills. In response to this problem, CENS offers courses based on the Model of Reference Competencies in Health Information Systems and certifications to technicians and professionals with demonstrable digital competencies. This effort will strengthen job profiles and certifications related to the country's needs. The model guides the design of undergraduate and postgraduate training programs and establishes common training standards. The areas of this model comprise the transformation in health and transversal technology of eight work performance domains: (i) management of health information systems; (ii) innovation and transformation in health; (iii) decision support systems; (iv) secondary use of health information; (v) management of people and organization; (vi) process architecture; (vii) interoperability and standards in health information systems; and (viii) design and development of health information systems.
- In Argentina, the Department of Health Informatics of the Hospital Italiano offers a Master's Degree in Health Informatics, both at a distance and on-site. The purpose of the master's

degree is to promote the development of competencies to apply the principles of health sciences, computing, communication, information, administration and management in an integrated manner to the organization, analysis and use of information in the health system and health information systems.[187]

- In Colombia, Universidad del Bosque offers a master's degree in biomedical informatics, mainly in the areas of translational bioinformatics, clinical informatics and public health informatics.

Digital health increases the capacity of the healthcare workforce

Digital technologies have had multiple positive effects. There are numerous ways in which digital technology is transforming the activities of the healthcare workforce: facilitating access to education and training, modernizing infrastructure and care processes, helping to reduce shortages and improving HCWs' performance.

Digital technology also presents risks and challenges. Some of those that can be mentioned consist of:

- Unequal access to digital technology, due in part to the fact that there may be economic interests that create a bias in technological development towards the needs of countries with more resources in Latin America and the Caribbean. This situation in turn generates potential disparities both for HCWs to access technology and for users to utilize health services. Consequently, health outcomes will also be heterogeneous.
- There are information security and privacy risks. Digital technology requires the collection and storage of data and in the region, policies, standards and regulations for data protection are just beginning.
- Sustainability risk. Implementing and maintaining digital systems requires a substantial investment in human, physical and financial resources. The initial investment must ensure that health systems use best practices in digital health. In addition, the sustainability of digitized health systems must be ensured from the planning stage.
- Information asymmetry between users and HCWs. Users need to improve their health and digital literacy to understand their health problems and participate in their treatment.

- The availability of technology and access to indicators and evidence is a positive change. However, the interface of HCWs with technology and data can distract HCWs from contact with patients, focusing more on the technology than on the interpersonal relationship.

Telehealth and telemedicine are essential tools in health services. Telehealth refers to surveillance, health promotion and public health actions, and telemedicine is the use of telecommunications to diagnose and treat diseases. Telemedicine links primary care and hospital services, provides medical doctors with certainty about their decisions through peer consultation, and facilitates patient access to diagnostic procedures and treatment without having to travel long distances, while helping to reduce referrals and costs. Additionally, telemedicine has transformed medical care and the interaction between medical specialties and generated changes in traditional models of care, which are replacing the traditional vision of in-person care with virtual care and real-time patient monitoring. Uruguay[188] and Chile are leading the implementation of telemedicine in the region. In addition, Argentina, Colombia, Ecuador and Peru are rapidly expanding telemedicine services, which has led to cost reduction and diversification of services, also allowing an increase in the volume of patients attended.

Tele-alarm and tele-assistance services allow patients to be cared for and their health status to be monitored remotely. Digital technologies strengthen services for care, remote monitoring of health status and response to emergent situations, which provides certainty and improves the quality of care to patients, and provides greater peace of mind for care-givers and family members.[189] Tele-alarm and telecare services for the care of older adults are new in the region, and have positive benefits for users and the health system, as their cost is lower compared to traditional care services.[190] In addition, they contribute to reducing the problem of HCWS shortages.[191]

Digital technologies are used for training in geriatric care. Digital technologies make it possible to overcome the deficiencies in the number of available teachers and access to educational programs.[192] These services are incipient in Latin America and the Caribbean. However, they are triggering training and the creation of new jobs.

In response to the advanced aging of its population, Uruguay has made significant progress in the training of digital HCWs for the care of older adults:[193]

- In 2017, Uruguay launched the personal assistant service for people with severe dependency and telecare for people over 70 years of age, in a situation of mild or moderate dependency.

- In 2018, the Uruguayan Government initiated the provision of daycare center services that provide comprehensive care to older adults. These services required 2257 new jobs and the implementation of the Human Resources Training Strategy for Dependency Care (people with disabilities and the elderly). The results are visible, in that same year the coverage of personal assistants and telecare services reached 66% of the elderly over 70 years of age in a situation of dependency.

Digital technologies maximize the capabilities of HCWs. Artificial intelligence for the interpretation of images (X-rays, CT scans, ultrasound scans) and anatomopathological tissue samples has achieved a level of reliability equal or superior to human skills. For example, radiologists, dermatologists and pathologists are changing the way they work. Since the technology currently available offers greater sharpness on computer screens, image interpretation can be done remotely and by means of artificial intelligence. The reading of dermatologic images for the diagnosis of melanoma using artificial intelligence and deep learning algorithms achieves an accuracy of 93%.[194] In Mexico, the IDB financed the implementation of an intervention to introduce artificial intelligence for the detection of diabetic retinopathy. This condition affects 33% of patients with diabetes and is diagnosed in advanced stages, resulting in significant vision loss and even blindness. The implementation of artificial intelligence has made it possible to detect retinopathy with greater timeliness and lower cost and to accelerate specialized care.[195]

Innovations in medical[h] and digital technology are promoting new models of care and new competencies of the healthcare workforce. Health technologies are advancing at a rapid pace in different directions and blurring the boundaries between drugs, medical devices and digital technology. Artificial intelligence, remote sensors, robotic surgery, genomic medicine, stem cell therapy and nano-sensor drugs, among other technologies, are generating disruptive changes in the processes of care and in the activities and competencies of HCWs. In this sense, it is essential to understand how technology will impact the labor market in the future, it is vital to reflect more deeply on the current state of technology and the state we believe it will be in the future, and to analyze its potential influence.

Minimally invasive surgery is constantly expanding and is having an impact on the quality and performance of surgeons. Surgery is a field of rapid technological innovation.

h. The definition of medical technology consists of the application of organized knowledge and skills in the form of devices, drugs, vaccines, procedures and systems that were developed to solve health problems and improve the quality of life. Health technology includes pharmaceuticals (drugs), biologics (such as vaccines), procedures (e.g., minimally invasive fetal surgery), support systems (such as electronic medical records), consumables (cardiac catheters), and medical devices (*gamma knives*).

Minimally invasive surgery is comprised of endoscopy, laparoscopy and robotic surgery. These less invasive techniques have greater precision than traditional surgical techniques. Medical robots are divided into three categories: controlled supervisory, tele-surgical and shared control. Controlled supervision robots require the surgeon to plan the entire surgery before the operation, then the robot performs the surgery under the close supervision of the surgeon. Tele-surgical robots allow the surgeon to directly control the robot and its instruments throughout the procedure from a remote location. Finally, shared control robots allow the surgeon and the robot to simultaneously control instruments and movements.

From the point of view of the training and performance of HCWs, three aspects stand out with regard to robotic surgery: (i) the learning curve for handling robots takes several months and depends on the number of surgeries that the surgeon performs; (ii) robots are used in surgical specialization programs and facilitate performance evaluation of surgeons in training; and (iii) robotic technology records the surgeon's movements and actions, information that is used to measure surgical dexterity, manual skills, and provide training and feedback. In the United States, the robotic spine surgery market is expected to increase to US$2.7 billion by 2022, which will translate into increased requirements for trained HCWs.[196] In Latin America, Brazil is the leader in robotic surgery with 50% of the equipment. Other countries making progress are Mexico (15%) and Chile (11%).[197] The biggest obstacle to robotic surgery is cost, which limits countries' ability to acquire the equipment. In addition, there is a shortage of medical doctors trained in robotic surgery in the region. A survey in Brazil on the process of certifying surgeons for the use of these technologies reported that 45% of surgeons were certified for robotic surgery and, in general, these were younger and worked in cities of more than one million inhabitants compared to those without certification.[198]

Technological innovation at the service of healthcare workers

Technological innovation influences healthcare workforce planning. Digital technology and automation are changing the activities of HCWs. Technology facilitates their tasks and, in many cases, complements and can even perform repetitive tasks that do not require HCWs. Latin America and the Caribbean will take years to digitize and automate healthcare, which provides some scope for understanding the effect of the convergence of technological innovation and the health workforce on the development of future skills and new models and processes of care. However, it is essential for strategic workforce planning that

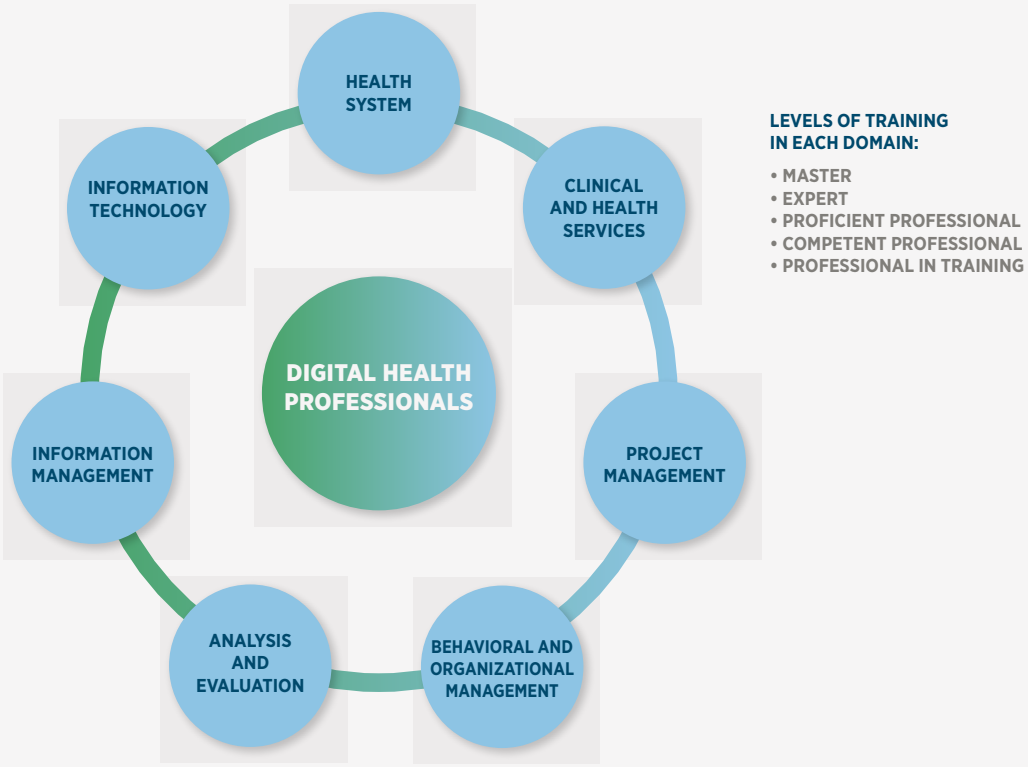
decision-makers have an informed perspective on the effect of digitization and automation and understand the differences in activities that computers or robots can perform and those that require human qualities such as creativity, empathy, trust and interaction.

Digital health requires investment in human resources. Health systems that are successfully modernizing their information systems are incorporating and training researchers, data security experts and biostatisticians in health information management. They are also training health services managers and HCWs in the basics of data science and computing. HCWs, including managers and operational staff, must have the requisite knowledge and skills to collaborate with computer, information systems and legal experts to use digital technology tools safely. To effectively use technology, it is imperative to transform worker education and training and lay the organizational foundation to manage change and enhance their digital skills for their daily work.[199]

The convergence of digital technology and healthcare is creating multiple profiles. Digital health profiles have a broad taxonomy. Digital Health Canada is a not-for-profit association targeting digital HCWs, which developed a matrix of seven domains of digital HCWs: (i) clinical and health services; (ii) health system; (iii) project management; (iv) behavioral and organizational management; (v) analysis and evaluation; (vi) information management; and (vii) information technology. For each domain it established five formative levels comprising: professional in training, competent professional, proficient professional, expert, and master. This combination results in 35 different profiles of digital HCWs. The organizational characteristics of health systems should strategically define the type of digital HCWs they require

CHART 3.2

PROFESSIONAL DOMAINS IN DIGITAL HEALTH



Source: Own elaboration.

Interaction between users and healthcare workers is digitized

Users have access to more health information through digital technologies, the Internet and social networks. The increased accessibility of health information is promoting growing health and digital literacy, which makes it easier for users to become active participants in their healthcare rather than passive recipients of services.[200,201] Digital technology makes it easier for users to understand their health condition, streamlines communication with HCWs, reduces information asymmetry, improves their ability to make decisions, and promotes self-care.[202]

Users demand transparency, convenience, access and personalized services for their healthcare. Patients and family members or caregivers use the Internet as a first option for seeking information about their health, seeking medical care, asking questions in a more targeted way, understanding medical explanations and indications, being assertive in communicating, participating in decision making and taking an active role in the care of their disease. Internet information is available on portals, blogs, online self-help groups, social networks or cell phone applications, which, although has positive aspects, is not free of risks, as users can use erroneous information that motivates them to make the wrong decisions, discourages them from seeking medical care or generates anxiety.[203]

Users support each other and share information and experiences. There is a significant trend among users to digitally join groups of patients with the same disease to exchange experiences, information and support each other. People are the most important part of any information platform that allows groups to collaborate and preserve or expand their reputation to seek personalized solutions.[204] For example, PatientLikeMe is a personalized health network with more than 750,000 people living with 2,900 diseases and has generated more than 43 million data points, creating a source of real-world evidence and opportunities for ongoing learning. The Dr. Susan Love Foundation for Breast Cancer Research supports and facilitates breast cancer research for all people, with 380,000 members to whom it provides ongoing access in breast cancer-related research studies.

New technologies favor interaction between healthcare workers and users. The availability of smartphones and telemedicine services is reducing the restrictions of time and place, facilitating the exchange of information and services between users and HCWs. Technology favors access to medical care, allows permanent monitoring of the patient's health status, facilitates user-provider and provider-provider communication, aids in decision making and improves the quality of care.

Healthcare workers require effective communication skills, knowledge of new technologies and the ability to interpret information. The interaction between users and HCWs requires effective communication skills, since during care, the user describes his or her symptoms, thoughts or doubts to a professional who must have the knowledge to understand and provide the best care in the context of the patient's symptoms, thoughts or doubts, and who must have the knowledge to understand and provide the best care in a culturally acceptable context. In this sense, it is important to reiterate that technology is a tool that facilitates the collection and analysis of information, decision-making and the provision of necessary care, but it does not and will not replace the human contact that

users and HCWs require during healthcare. The relationship between the user and the HCW is individual and based on trust, which should motivate the use of secure technologies to guarantee the security and confidentiality of the information.

Digital information generates a different ecosystem for HCWs. The increased involvement of users has motivated HCWs to learn new ways of interaction and communication to establish an empathetic and sensitive relationship with the health, social and cultural aspects of patients and their families. HCWs must have multiple competencies to interact with users using digital technology. For example, they must be able to teach users how to access their personal data and how to use technological tools to their benefit and to make decisions regarding their health status, their treatment and access the health benefits to which they are entitled.

Given the greater availability of health information, users require guidance in searching for and interpreting information, which should encourage a change in the attitudes of HCWs. For example, it has been identified that medical doctors react in different ways to informed users: (i) they feel confrontational and respond defensively by resorting to their "expert opinion"; (ii) they collaborate with patients to obtain and analyze information; and (iii) they guide patients to reliable information sites.[205] Training HCWs to discuss and use information from the Internet is an unmet need and refusing to discuss information with patients erodes patients' trust in HCWs.

HCWs must be able to understand the digital divide when caring for vulnerable people. Low-income users living in remote or rural areas may lack access to the internet or smartphones, as well as users from diverse groups, particularly older adults, may be "digitally illiterate", regardless of their social or formal educational level. Patient choice should also be considered. Users may decline to use mobile devices or refuse to share their information, so it is essential to consider these aspects in the competencies of HCWS.

Episodic care is shifting to continuous care. Digital technology is replacing the traditional medical model of episodic care and intermittent medical consultations with a continuous care model, supported by the continuous generation of data about the individual's health conditions. In addition, technology is streamlining contact between HCWs and users. The continuous production of health data from portable devices and digital platforms represents the generation of an ecosystem of interconnection between the user, caregivers and HCWS. The interconnection generates different possibilities for communication, decision making and data generation, mainly informing the patient and his or her caregivers, but also the HCWS, the healthcare system, whether public or private, and the insurance companies.

Wearable devices facilitate health status monitoring. Wearable devices including smartphones and smartwatches represent an additional and continuous source of data that enable constant, non-intrusive tracking and monitoring of patients' health status. In addition, information can be shared with other data repositories, such as an electronic medical record. Some of the parameters that are measured and recorded are heart rate and rhythm, blood pressure, eye health, respiratory rate, glucose levels, blood oxygen saturation, calories, daily activity, sleep patterns, cognitive status, and mental health.[206] The availability of data allows for early identification of abnormalities (e.g., sudden elevations in blood pressure or glucose, or cardiac arrhythmias). Abnormalities trigger alarms in digital systems and generate treatment decisions by HCWS and even the automatic response of some devices, as in the case of blood glucose monitors that, when they detect elevated numbers, activate insulin pumps.[207]

4

The healthcare workers of the **future**

Healthcare workers will continue to face challenges

It is necessary to plan for the future in order to face unsolved challenges. The future health workforce must be a priority for health systems. Efforts should not focus on filling the shortage of HCWs in order to have a specific number. The mere availability of a certain number of professionals would not be sufficient. The advancement of HCWs cannot be quantified in a number. Thus, it is essential to develop strategies appropriate to the multiple categories and competencies of HCWs working in such different environments in different countries. The problem is complex and the lack of planning and investment with a long-term perspective will limit the implementation of effective solutions and, as a result, unequal distribution, imbalance of competencies and skills, erroneous knowledge and practices, lack of continuing education, shortage of supplies, obsolete technology, as well as precarious working and contractual conditions will continue.

The future is arriving before healthcare HCWs acquire the capacity to understand, adapt and act accordingly. HCWS must be equipped with analytical skills and the ability to adapt to change. The impact of the future on healthcare systems[208] and HCWS has been extensively analyzed.[209,210] In their daily work, HCWS need to have the skills to adapt and work in a context of technological innovation and constant and rapid change. They must also be able to overcome the fear of being displaced by the automation and digitization of healthcare services. In practice, adaptability and change management are not individual behaviors, but rather participatory and collective processes that require qualified HCWs to lead them.

New ethical issues

Medicine has always been at the intersection between science and society, and medical technology advances faster than the development of ethical and legal standards. This situation is not new. There are a number of complex ethical situations in healthcare. For example, in reproductive health rights issues, the debate persists on access to abortion,[211] in vitro fertilization, access to fertility services for transgender and non-binary people.[212] Cloning and euthanasia remain under constant analysis and discussion.

The COVID-19 pandemic triggered ethical issues arising from problems secondary to rationing and the fair allocation of scarce medical resources. In Latin America, disparities were visible at the individual level: for example, not all patients had access to COVID-19 testing, intensive care unit beds, ventilators or drugs. Also, between countries, problems of access to vaccines were observed. In other words, not all patients with COVID-19 were able to use the health services they needed and not all the population had access to vaccines. In addition, the most vulnerable populations in social and economic terms were the most affected by COVID-19, which indicates that the social determinants of disease and health (poverty, unemployment, precarious housing, pollution) transcend the bioethical problems of health services.[213]

New technologies will raise ethical issues of access, equity and effectiveness that will require the attention of healthcare workers and health-related disciplines. The risk is that the gap between those who will have and those who will not have access to technological innovations will widen, due to the cost and disparities within and between countries in the region. Some examples of technology that will become widely available are: precision medicine based on an individual's genetic makeup, tests to detect dementia, 3-D printing to replace organs, limbs and bones, creation of artificial organs to replace damaged organs, generalization of robotic surgery that will allow more complex surgical procedures in more countries.

Inter-professional team care will not be without ethical issues. The growing number of medical, nursing and other specialties presents a challenge in coordinating care. Who can be assigned responsibility for care? Who coordinates and approves procedures? Specialization and the involvement of interprofessional teams can improve the quality of care, but it will also have an impact on efficiency, costs and the organization of services, which may eventually translate into less access and greater inequity for those who lack the resources or health insurance to access modern health services.

What are the proposals to overcome these challenges?

Healthcare workers must have essential competencies for the future. Competencies are defined as knowledge-based actions that combine and mobilize the skills and attitudes needed to care for users and the community safely and with quality with the resources available.[214] The perspective is not how much a person knows, but what he or she can do with what he or she knows and in the best possible way.

New competencies will be required in a future with complex health needs, constant technological innovation and resource constraints. The expectation for the future is that HCWS will have to fully meet health needs and have the skills to provide user-centered care, not just technical training to treat disease. In addition, they will have to adapt to technological changes. Digital technology will be an everyday tool that will help mitigate worker shortages, imbalance and inaccessibility and increase efficiency in planning, training, management and performance evaluation. The introduction of technological innovations will contribute to effective schemes that favor the equitable and accessible distribution of HCWS in the population. In-person care and the institutionalization of synchronous and asynchronous virtual care will make it possible to expand service coverage.

What attributes of the healthcare workforce of the future are desirable?

Innovations will define the characteristics of the healthcare workforce. Innovations in workplace models of care and the use of digital technology will drive changes in education and in the day-to-day skills and tasks of HCWs. They will not only need to have technical skills; they will also need to have communication competencies, empathy, emotional balance and resilience, and the ability to adapt to constant change to meet emerging job roles. While these skills are not new, it is important to emphasize that they are more relevant than ever given the increasing complexity of health problems, the importance of interaction between HCWS, users and the use of technologies.

Healthcare workers will need to deepen multiple competencies to provide effective services.

- Social-emotional competencies are focused on communication skills, problem solving, critical and creative thinking, lifelong learning, empathy, agility and emotional resilience.[215]
- Technical and professional competencies are comprised of knowledge, training in the use of scientific evidence and experience.[216]
- Digital competencies include the skills to collect, analyze, use, and disseminate information, taking into account ethical and security aspects.[217]
- Change management competencies enable HCWs to adapt to a constantly changing environment, and to design their working future by being able to identify their current situation and forecast the future situation of their skills, tasks and position within the organization, and to prepare for change.[218,219]

CHART 4.1

COMPETENCIES OF HEALTHCARE WORKERS TO PROVIDE HEALTH SERVICES IN CARE NETWORKS

Source: Own elaboration.

Communication and empathy. Users require emotional attention and empathy from HCWS, but they do not receive them to the extent they need. It is desirable that HCWS have greater sensitivity and the ability to discern ethical issues and act morally. These characteristics define the interaction between people and could not be replicated by technology. Telecare models for older adults have demonstrated the importance of interaction between HCWs and users.

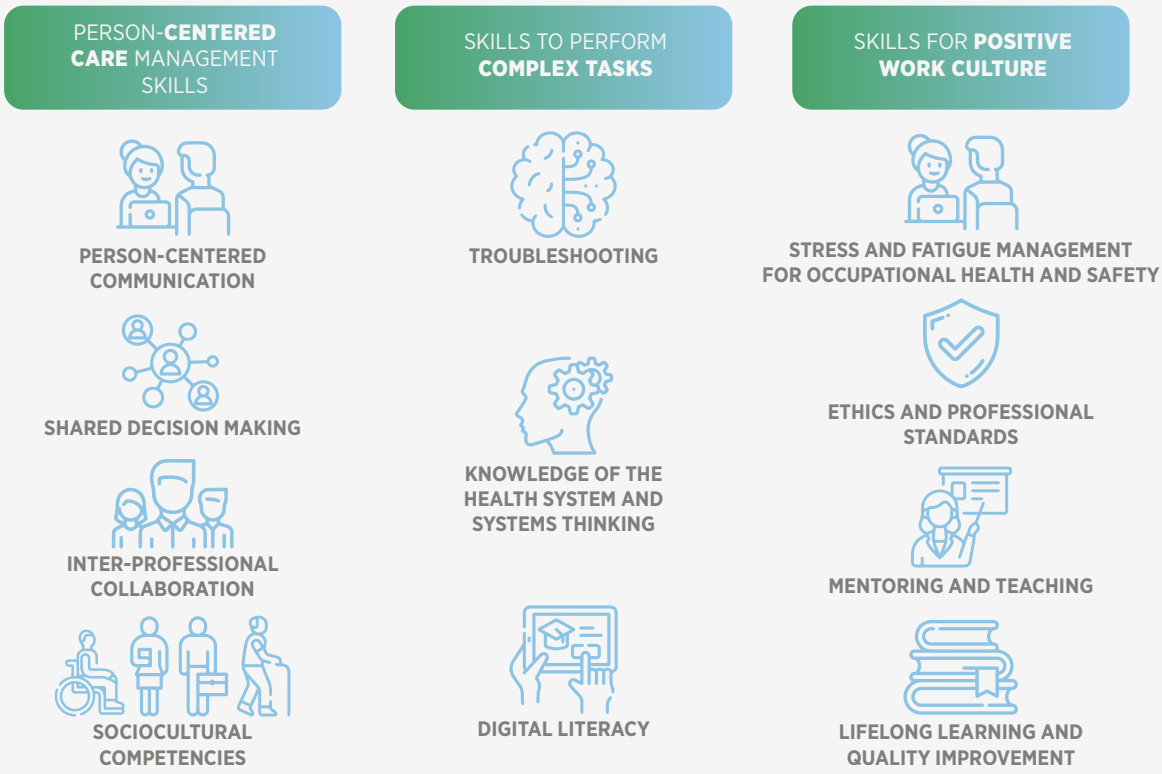
Emotional resilience. HCWS will need to strengthen their emotional capacity. Caring for patients with complex needs such as dementia, cancer and terminal care requires emotional resilience. Worker burnout has been linked to changes that reduce their ability to control their work, impair their relationship with clients, interfere with their work-life balance, and cause stress.[220] For example, those treating patients with severe complications of COVID-19 faced significant stressors. Fear of contagion, concern about protecting the family, distress at seeing patients die in isolation from family members, and anxiety over decisions to ration intensive care beds and ventilators were daily occurrences during the peaks of the pandemic. Studies in 21 countries reported prevalence of depression, anxiety and post-traumatic stress disorder of more than 20% among HCWs.[221]

Change management capacity. It will be essential for HCWs to acquire the tools to envision what the future will look like and respond accordingly, rather than passively waiting for the future to arrive. HCWS need to keep pace with technological advances, adapt to technology and work in environments of uncertainty and continuous change. The speed of technology introduction will require HCWs to acquire skills and abilities to constantly learn and have an anticipatory attitude. New technologies increase the pressure on health services to innovate, on the education system to update its training models, and on the individual to take control of his or her learning. The digitization of care now requires that HCWs have the capacity to collect, analyze and use information.[222]

The OECD proposes a comprehensive framework comprising four domains: (i) patients; (ii) organization and management; (iii) education and research; (iv) professional practice and population, which respond to the trend toward person-centered care models. Based on these domains, person-centered care management skills are proposed for the performance of complex tasks and positive work culture[223] (Chart 4.1).

CHART 4.2

THE FUTURE HEALTH WORKFORCE. TRANSVERSAL COMPETENCIES



Source: Own elaboration based on Maeda and Socha-Dietrich (2021).

Education for the future

There is a pressing need to expand the perspective of health education programs. Educational programs should identify healthcare trends and develop options relevant to real market needs. Educational resources should be developed to educate and train HCWs in alignment with the competencies relevant to the type of work, role, level of responsibility, and place of work.

It is crucial that healthcare education programs prioritize the development of educational spaces for new professions such as robotics engineers, data scientists and other technical specialists in the healthcare field. These new professions will enable the creation of innovative technological solutions to improve care and productivity without undermining ethical and patient safety considerations.

Recommendations include curricular reforms to increase skills in caring for seriously ill older adults, expanding learning opportunities in careers in geriatric and palliative care, developing and enhancing curriculum in inter-professional and cultural skills, preparing professionals to support the incorporation of home care aides and family caregivers as members of the healthcare team, developing skills to support shared decision-making with patients that require specific skills related to serious illness.

Healthcare workers will receive genomic literacy. Genomic medicine training will enable HCWs to understand the basis, benefits, and ethical considerations associated with genomics. Ongoing training in genomic medicine should be accessible to HCWs in contact with patients, including access to dynamic digital updates and online genomic information resources. Similarly, accredited genomics training for healthcare professionals should be established in key clinical specialties to incorporate genomic testing and counseling into their practice.

Digital and technological literacy gaps in health workforce training are reduced. Educators must ensure that students achieve an appropriate level of digital and technological literacy. Thus, trainees, both in healthcare and in areas related to engineering, computer science and data science, should be prepared to collaborate interdisciplinarily in the creation of solutions to healthcare problems.

Technologically compatible healthcare environments will be created jointly between the different disciplines in the areas of healthcare, technology, digital and with the participation of users. The diversification and interaction of the different educational fields will make it possible to close HCWs' gaps in the areas of genomic medicine, digital health, artificial intelligence and robotics, among many others. For example, nurses will have an increasingly critical role in assisting, supporting and educating users around the selection and use of healthcare technologies. Their training will enable them to reconcile their values as nurses and vision for the future with the exponential growth of technology and the complexity of care services.[224]

In the next two decades, most jobs in the National Health Service in the United Kingdom will require digital components.[225] It is to be expected that Latin American and Caribbean countries will follow the same trend. A systematic review identified 28 domains of digital competencies derived from different frameworks applied in the health workforce[226] (Table 4.1).

TABLE 4.1

EDUCATIONAL FRAMEWORK FOR DIGITALLY COMPETENT HEALTHCARE WORKERSE

Administration and management of services	Information analysis	Attitudes towards information technology	Clinical care	Communication to increase interpersonal skills
Clinical decision support	Documentation of care	Education and Training	Ethical, legal and regulatory aspects	Financial management
Health information management	Information quality and security	Imaging	Informatic concepts and processes	Integration and interoperability
Information technology promotion	Leadership and management	Medication management and administration	Patient access to and involvement in self-care	Privacy and security
Project management	Public Health	Remote service	Research	Risk management
Implementation of systems	Technical support knowledge			

Source: Own elaboration based on Nazeha et al. (2020).

Technological change will not replace the healthcare workforce

New medical and digital technologies will bring users closer. Telemedicine, telediagnosis and robotic surgery services will be provided from any location with trained HCWs, as well as digital technology, Internet connections and electrical power. It is possible, for example, to remotely diagnose and monitor the health status of patients with chronic diseases, which speeds up clinical decision-making and promotes adherence to treatment and compliance with appointments.[227,228,229] Several analyses have shown telehealth to be cost-effective for patients with diabetes[230] (e.g., tele-ophthalmology) and cardiovascular diseases.[231] During the COVID-19 pandemic, social distancing, the reallocation of health facilities and HCWs to care for COVID-19 cases, together with the need to continue to provide essential health services and protect HCWs from infection, led Latin American countries to accelerate the introduction of telemedicine, although it will be necessary to strengthen legislative, regulatory and information security[232] matters. It is hoped that this upward trend will continue. In the context of the Global Strategy and Action Plan on Innovation in Public Health and Intellectual Property, the World Health Organization, with support from the European Union, has published compendia of innovative health technologies for low-resource facilities. This

type of platform is useful for the identification of low-cost technologies, such as e-health solutions, medical devices, outbreak and epidemic technologies, assistive devices (such as prostheses), and medical devices.[233]

Healthcare workers will interact with technology on a daily basis. It is necessary to forecast how HCWs will interact with technology and to precisely define the tasks they will perform in order to design efficient interfaces. Technologies already exist that automate repetitive and administrative tasks, allowing HCWs more time to use their cognitive skills. For example, the aging population is one of the key drivers of the growth of the robotics market. The use of commercial and personal robots is an appropriate method of supporting people, especially the elderly, in their daily tasks at home or at work.

Technology will not replace healthcare workers. Innovations generate uncertainty among those who perceive that sudden changes affect their life and work. In the future, it is envisioned that tasks will be distributed between HCWs and technology. Therefore, it is essential that HCWs clearly differentiate the activities that technology will perform from those that will continue to require human qualities, such as creativity, empathy and interpersonal relationships. This must also take into account the technological changes that are taking place and that are being incorporated into the daily work of the HCWs. The capacity for constant learning, creativity and collaboration in multidisciplinary teams will be some of the HCWs' skills that will define their interaction with technology. The work of HCWs caring for children and older adults has a low prospect of being automated.

Healthcare workers will have more room for interpersonal relationships. The automation of routine and repetitive tasks means that HCWs will be able to focus on tasks that will allow them to use their creativity and empathy, key human experiences that cannot be automated at present and that represent the core of the relationship between HCWs and users. There are significant aspects of being human that cannot currently be replicated by technology, which means that the future will consist of complex human-technology relationships that will challenge and modify our current ways of working.

Artificial intelligence will complement and augment human capabilities, not replace them. Technology will support the performance of complex tasks. Digital health, together with artificial intelligence, robotics and genomic medicine, will support the achievement of goals to improve healthcare for the population, without the unfounded fear that HCWs will be replaced by technology. Rather, their capabilities will increase, allowing for more interpersonal care time. Virtual reality has the potential to revolutionize the field of mental health by providing new tools for the detection, diagnosis and treatment of mental health

conditions. For example, exposure therapy creates realistic simulations of anxiety-provoking situations, such as fear of heights or fear of certain social situations. This exposure therapy helps individuals confront and overcome their fears in a safe and controlled environment. It also has the potential to be used in certain types of psychosis, autism spectrum disorders and addictions.[234]

Workplace and the point of healthcare are definitively separated

Healthcare workers will work in an environment of constant change. The traditional notion of in-person care in health facilities such as clinics and hospitals will be transformed. Technology-based work environments and networking allow greater freedom with respect to the location and working time of HCWs. Technology will facilitate worker mobility and it will be possible for a large proportion of individual services to be provided in virtual settings, at the user's home or in the community, and to a lesser extent in clinics and hospitals. This change will potentially reduce the costs of care for both health services and users, facilitate access and reduce waiting times.

The separation of the workplace and the place of medical care will change the structure of the labor market. In the near future, it will be essential to redesign the contractual and working conditions of HCWs, generating efficient hiring models that respect the rights of HCWs but allow for mobility and flexibility. The entry of the millennial generation into the workforce has changed expectations about work-life balance, promoting flexible careers, rewards and incentives, improving relations with employers and promoting the use of technology.

Remote work, together with task shifting and skill mix, will promote the accessibility and flexibility of healthcare services. The healthcare workforce is very diverse and will gradually consolidate task shifting and skill mix to be compatible with user needs. Digital work platforms will enable greater collaboration between individuals and multidisciplinary work teams.

Digital technology will improve the performance of healthcare workers

Uncertainty and errors in diagnosis and treatment. Medical doctors and nurses often diagnose and make therapeutic decisions based on limited information. There are six determinants that influence medical errors: poor organizational design, excessive workload, time pressure, teamwork constraints, individual human factors and case complexity.[235] Sometimes HCWs choose a treatment without an accurate diagnosis[236] and, even if they know the diagnosis, they must select the treatment from the limited options available. Consequently, the expected effects cannot be predicted without uncertainty. In addition, the treatment decision must be shared with patients or their caregivers,[237] which represents uncertainty regarding the appropriateness of decisions for both caregivers and HCWs.

HCWs must move from simple reasoning and intuition to the use of logic and evidence. HCWs are often overwhelmed with daily tasks, fail to keep up-to-date with the large amount of scientific information that is produced daily and lack the tools, time and resources to convert information into knowledge applicable to their clinical practice. There are many alternatives for accessing scientific information, but it is difficult to translate knowledge into decisions and actions in daily practice. However, there are alternatives that will gradually become generalized. Cognitive programs are being used in medical practice to apply natural language processing to read scientific literature and collate years of electronic medical records. In these and other ways, artificial intelligence will be able to optimize the care trajectory of patients with chronic diseases, suggest precision therapies for complex diseases, reduce medical errors and improve the participation of individuals in clinical trials.[238] Correct decision making must be supported by objective and accurate predictive judgments.

New solutions to unsolved problems. In the near future, the potential benefits of digital medicine and technological advances, such as early diagnosis, seamless and personalized care and treatment, will be tangible. The increased availability of clinical data on a continuous basis and the utilization of medical technology will improve the quality of care and increase the likelihood of achieving desired health outcomes. The expectation is for transparent and digitized medical care, widespread use of decision trees, use of electronic patients for education and research purposes, and the involvement of technology-savvy medical doctors without barriers to collaboration.[239] There are multiple examples of these advances becoming progressively more widespread.

Increased availability and accessibility of clinical information. The amount of clinical information and the tools to which HCWs will have access to make decisions is growing exponentially. To take advantage of the increased amount of clinical information, HCWs will need to incorporate new technologies such as remote monitoring, and in-depth analytics into their practice to more effectively engage patients, provide targeted diagnoses and treatments, and mitigate work overload. It will be possible to use data to provide an estimate of the patient's current clinical status (diagnosis) and future clinical status (prediction), which will support diagnostic and therapeutic decisions.[240] Machine learning enabled early warning systems that alert clinicians to the risk of patient deterioration perform better than existing clinical risk scores.

Machine learning. Clinical decision analysis techniques that are oriented to deductive reasoning, based on theories of probability and utility and that reduce uncertainty are evolving due to the use of *machine learning* and artificial intelligence.[241] The applications of *machine learning* in daily practice are multiple. Its use in radiology, clinical records, interpretation of laboratory studies, radiotherapy, surgery and ophthalmology, among others, stands out. The prognosis is that *machine learning* will contribute to changing the practice of medicine once it becomes widespread.[242] *Machine learning* models are also being used to measure the results of interventions and therapeutic programs.[243]

Deep learning. Deep learning technologies for automated analysis and interpretation of medical images demonstrate expert performance. Artificial intelligence will have a major impact on radiology, pathology and ophthalmology due to the availability of digitized data and interoperability standards. The spread of digitization, supported by trained HCWs and the right infrastructure, will lead to artificial intelligence improving clinical diagnoses, which will improve the performance of healthcare services.

Everyday use of wearable devices as part of medical care. Non-invasive wearable devices will become widespread. Information on various parameters such as physical activity, glucose, oxygen, heart rate, sleep duration, will be used as part of routine clinical information. Data storage and interpretation will occur automatically to inform the user, HCWs and artificial intelligence mechanisms. The availability of information will facilitate preventive and therapeutic decision making, and reduce the need to visit the doctor's office, laboratory or clinic. Clinical studies of *smart watches* that use photoplethysmography to monitor heart rate are demonstrating their potential to identify abnormalities in heart rhythm and alert users to seek medical attention in a timely manner. Such innovations will help reduce morbidity and mortality from cardiovascular disease.[244] Researchers at the University of

Washington turned smart speakers, such as Alexa or Google Home, into heart monitoring systems. The machine learning algorithm detects irregular breath sounds, which accompany cardiac arrest events. The smart speaker could raise the alarm, even if the affected person is incapacitated.[245] Access to such wearable devices will become widespread as part of the treatment of conditions that require constant monitoring.

Automation of administrative tasks and repetitive tasks. Automation of routine and repetitive tasks will allow HCWs to focus on patient care. Routine activities that have explicit rule-based processes can be performed by algorithms, deep learning, and robotic systems. As a result, these systems are replacing human labor in a wide range of routine manual and cognitive tasks. In healthcare, artificial intelligence is being successfully applied to analyze images in ophthalmology, radiology, pathology and dermatology with superior diagnostic speed and accuracy similar to that of specialists in these areas. As a result, artificial intelligence and algorithms can amplify the capabilities and complement the shortage of specialists. While diagnostic confidence is never 100%, the combination of machines and specialists would reliably improve the performance of healthcare services.

The internet of skills and artificial intelligence. These tools are incorporated into medical care. For example, the internet of skills uses ultrafast, low-latency 5G connectivity to allow the surgeon the ability to operate remotely, with delays of less than 10 ms for distances of up to 1500 km. In addition, the robots will be able to be programmed using artificial intelligence and machine learning to predict surgical movements, allowing the surgeon to operate from even longer distances with an even shorter delay. This technology could also be expanded to surgical training programs. Many virtual reality and augmented reality systems are already incorporated into surgical training programs, and some of these simulation platforms have been correlated with improvements in operating time and overall performance of trainees.

Genomic medicine breaks into everyday work

Genomic medicine applies knowledge and understanding of all genes and genetic variation in human disease. From the sequencing of the human genome, approximately 23,000 genes and their regulatory regions have been identified, which is facilitating the understanding of the molecular basis of disease. Knowledge of the genome is driving the development of genomic tools and disease-specific molecular genetic tests.

The use of user genomic information as part of their clinical care is gaining acceptance in routine practice. Genetic testing has moved from being primarily focused on the genetic diagnosis of families with inherited disorders and birth defects to the genomic sequencing of individuals in everyday medical practice, which in the future will allow for increased stratification of diagnoses and treatments. Advances are tangible in activities to assess disease risk in individuals and their families, in detection and diagnosis of rare diseases, in predicting treatment outcome in different areas of medicine, for example, to improve the safety and efficacy of drugs.[246] It is already possible to diagnose chromosomal aberrations such as Down syndrome and Prader-Will syndrome, among many others, during the first weeks of pregnancy and prenatal care. These advances will significantly improve the opportunity to prevent and treat congenital malformations.

Advances in genomic medicine will change the practice of medicine. The expectation is that medicine will become more focused and individualized. Recent terms include "personalized medicine" and "precision medicine." The training of HCWs in genomic medicine is evolving, although it has been warned that the training of HCWs, the generation of knowledge and its clinical application in this area are not yet aligned.

The advance of genomic medicine poses new challenges for healthcare workers. HCWs will have to face new legal, ethical and social challenges arising from the use of digital and genomic technologies in healthcare services. In particular, those related to patient safety, data governance, equity, justice and respect for human dignity. The creation of increasing amounts of identifiable personal information with a multiplicity of medical and other applications has new legal and ethical implications for information security and decision making. The challenge will be to interpret the variants in individual families and populations, protect individual privacy, and manage public expectations and the definition of responsibilities of HCWs and those who have access to information.[247]

Climate change is no stranger to healthcare workers

Greater understanding of public health and the effect of determinants of health is required. It is essential that HCWs acquire the ability to analyze in perspective the consequences of decisions to address the health and disease of both individuals and populations. It is a priority for HCWs to have specific competencies for dealing with health problems arising from natural disasters, climate change, and epidemiological emergencies.

Investment to address climate change consists of improving the coverage of health services and emergency and disaster risk management. These actions strengthen health resilience and security and should be accompanied by investment in HCWs in terms of their availability, distribution, and competencies to prevent, prepare for, respond to, and recover from emergencies. More focus is needed on the diverse roles of all HCWs in emergencies (e.g., in the planning of HCWs competencies to respond in an organized manner to emergencies and mitigating potential occupational hazards).

Healthcare workers should be trained in disaster response. HCWs closest to the community, such as general practitioners, nurses, community workers, and midwives, are the first line of HCWs who need to be trained in disaster care and management. The lack of appropriate health service responses at the site of disasters reduces the possibility of achieving positive results in the face of these events.

Skills and competencies that will be required in the future in response to changing disease patterns caused by climate change.

- Leadership and capacity to collaborate with civil society organizations, government and donors to design, implement and evaluate national, regional and local responsive interventions.
- Strengthening institutional capacity to train, update and develop the workforce to address aspects related to climate change and health, not only in emergency or disaster situations.
- Management of HCWs in emergency situations considering the number, distribution, competencies, functions and exchange of tasks.
- Training of HCWs in specific areas:
  - Public health and climate change: training for the use of epidemiological surveillance systems and health promotion prevention activities in communities exposed to risks derived from climate change.
  - Communication and crisis management skills, e.g., to work with a wide range of emergency workers (police, fire, ambulance, and others) to assess and manage patient care in hard-to-reach locations.
  - Socio-medical techniques for the care of specific populations, such as ethnic minorities, population residing in high-risk geographic areas, including crisis or emergency care.

- Psychosocial techniques, e.g., post-trauma counseling or for the management of mental health conditions resulting from population displacement caused by prolonged drought or other factors.
- Basic clinical knowledge and skills to care for the population with infectious conditions and/or NCDs, e.g., older adults exposed to heat waves or freezing temperatures.

Final thoughts

- **The analysis of determining factors, the current situation, innovations and future characteristics of healthcare workers is based on a futuristic framework that makes it possible to outline what could happen and propose specific actions.** It is essential to create frameworks that make it possible to identify the competencies and skills needed for the different situations that HCWs face on a daily basis. Also it is essential to design and test care models and processes that maximize the potential of HWCs to perform their tasks and grow professionally, while fulfilling their social responsibility to care for and improve the health of the population.
- **Forecasting the future requires analyzing the contexts and trends in health, social, cultural, educational, economic, political, labor and even environmental settings.** These contexts determine future trajectories and provide the information to design strategies for HCWs and systems to prepare and adapt to change.
- **It is necessary to identify what can and needs to be changed.** It will be beneficial to identify the different likely and preferable trajectories in the context of the healthcare workforce. Academic institutions and health systems are challenged to ensure that HCWs are competent in an increasingly complex service environment that will require multiple technical, communication, digital, and social skills, in addition to the necessary emergency and disaster preparedness.
- **Technology is continually evolving, but change does not occur suddenly.** In an environment of limited resources and with the imperative of providing universal access to health services, it is essential to establish the potential impact of new technologies on the work of HCWs and in terms of costs, accessibility, sustainability and health outcomes.
- **The future of work is the future of learning.** Health systems, especially public health systems, will need to provide the professional development tools and resources to help the healthcare workforce develop this capacity for constant learning.

- **Healthcare workers will need to be able to expand their competencies to adapt to their new tasks and roles (which do not necessarily exist today).** HCWs should be prepared to actively participate in the changes that will occur in health services by adopting approaches such as design thinking and change management to develop, implement and test innovations in order to make better use of available resources without compromising quality. In addition, HCWs should be prepared to maintain an attitude of lifelong learning.

References

1. Voros J. A primer on futures studies, foresight and the use of scenarios. The Voroscope. 2021- 2022. A primer on Futures Studies, foresight and the use of scenarios – The Voroscope.

2. Tomblin Murphy, G., Birch, S., MacKenzie, A. et al. A synthesis of recent analyses of human resources for health requirements and labour market dynamics in high-income OECD countries. Hum Resour Health 14, 59 (2016) doi:10.1186/s12960-016-0155-2

3. Nigenda G, Ruiz A, Gonzalez-Robledo L, Wirtz V, Gonzalez-Robledo M, Aguilar M, Bejarano R. Training, employment and regulation of healthcare workers for health. Bases for strategic planning. National Institute of Public Health. Cuernavaca, Mexico 2010

4. Nigenda G, Machado M, Ruiz F, Carrasco V, Moliné P, Girardi S. Towards the construction of health workforce metrics for Latin America and the Caribbean. Human Resources for Health 2011, 9:24 http://www.human-resources-health.com/content/9/1/24

5. Jimenez m, Bui A, Mantilla E, Miranda J. Human resources for health in Peru: recent trends (2007-2013) in the labor market for physicians, nurses, and midwives. Human Resources for Health (2017) 15:69

6. Nigenda G, Muñoz A. Projections of specialist physicians in Mexico: a key element in planning human resources for health. Human Resources for Health (2015) 13:79

7. Ono T, Lafortune G, Shoenstein M. Health workforce planning in OECD countries: a review of 26 projection Models from 18 countries. OECD Health Working Paper No. 62. DELSA/HEA/ WD/HWP (2013)3. http://www.oecd.org/health/workingpapers

8. Tomblin G, Birch S, MacKensie A, Bradish S, Elliott A. A synthesis of recent analysis of human resources for health requirements and labour market dynamics in high-income OECD countries. Human Resources for Health (2016) 14:59 DOI 10.1186/s12960-016-0155-2

9. GBD 2019 Universal Health Coverage Collaborators. Measuring universal health coverage based on an index of effective coverage of health services in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. The Lancet. 2020; 396:10258:11250-1284. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30750-9/fulltext

10. Dmytraczenko T, Almeida G. Toward universal health coverage and equity in Latin America and the Caribbean. Evidence from selected countries. World Bank Group, Pan American Health Organization. 2017. https://openknowledge.worldbank.org/bitstream/handle/10986/22026/9781464811777.pdf?sequence=8

11. Economic Commission for Latin America and the Caribbean (ECLAC), Demographic Observatory, 2015 (LC/G.2675-P), Santiago, 2015

12. Economic Commission for Latin America and the Caribbean (ECLAC), Demographic Observatory, 2016 (LC/PUB.2017/3-P), Santiago, 2016

13. The World Bank. Life Expectancy at birth. https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=ZJ

14. Aranco N, Stampini M, Ibarraran P, Medellin N. Panorama of aging and dependency in Latin America and the Caribbean. Inter-American Development Bank. 2018. http://iadb.org

15. Marengoni A, Anglemana S, Melisa R, et al. Aging with multimorbidity: A systematic review of the literature. Ageing Res Rev 2011; 10:430e439.

16. PAHO. Non-communicable diseases (NCDs) in the Americas: quick facts and figures. Available at: https://iris.paho.org/handle/10665.2/51482.

17. GBD 2019 Mental Disorders Collaborators. Global, regional, and national burden of 12 mental disorders in 204 countries and territories, 1990-2019: a systematic analysis from the Global Burden of Disease Study 2019. The Lancet Psychiatry. 10 January 2022. doi: 10.1016/S2215-0366(21)00395-3.

18. Litewka SG, Heitman E. Latin American healthcare systems in times of pandemic. Developing World Bioeth. 2020; 00:1-5. https://doi.org/10.1111/dewb.12262

19. Pan American Health Organization. Geo-Hub COVID-19 Information System for the region of the Americas. https://paho-COVID-19-response-who.hub.arcgis.com

20. COVID-19 Excess Mortality Collaborators. Estimating excess mortality due to the COVID-19 pandemic: a systematic analysis of COVID-19-related mortality, 2020-21. Lancet. 2022 Apr 16;399(10334):1513-1536. doi: 10.1016/S0140-6736(21)02796-3. Epub 2022 Mar 10. Erratum in: Lancet. 2022 Apr 16;399(10334):1468. PMID: 35279232; PMCID: PMC8912932

21. Savedoff W, Bernal P, Distrutti M, Goyeneche L, Bernal C. Beyond normality. Challenges for the health sector in Latin America and the Caribbean as presented by COVID-19. Technical Note No. IDB-TN-2471.

22. Vasquez, L., C. Sampor, G. Villanueva, E. Maradiegue, M. Garcia-Lombardi. G. Chantada. Early Impact of the COVID-19 Pandemic on Pediatric Cancer Care in Latin America. The Lancet Oncology 2020; 21(6): 753-55. https://doi.org/10.1016/S1470-2045(20)30280-1

23. Doubova, S.V, H.H. Leslie, M.E. Kruk, R.P. Cuevas, and C. Arsenault. 2021. Disruption in Essential Health Services in Mexico during COVID-19: An Interrupted Time Series Analysis of Health Information System Data. BMJ Global Health 6: 1-11. https://doi.org/10.1136/bmj-gh-2021-006204.

24. Arsenault C, Gage A, Kim MK, Kapoor NR, et al., COVID-19 and resilience of healthcare systems in ten countries. Nat Med. 2022 Jun;28(6):1314-1324. doi: 10.1038/s41591-022-01750-1. Epub 2022 Mar 14. PMID: 35288697; PMCID: PMC9205770

25. United Nations. Climate change webpage. https://www.un.org/en/climatechange/what-is-climate-change

26. World Health Organization. Climate change and health. Key facts. https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health.

27. Cooper M, Brown M, Hochrainer-Stigler S, Pflug G, McCallum I, Fritz S, Silva J, Zvoleff A. Mapping the effects of drought on child stunting Proceedings of the National Academy of Sciences Aug 2019, 116 (35) 17219-17224; DOI: 10.1073/pnas.1905228116.

28. Nichols, A., Maynard, V., Goodman, B., and Richardson, J. Health, Climate Change and Sustainability: A systematic Review and Thematic Analysis of the Literature Environmental Health Insights, 3(1) URL: https://doi.org/10.1177/EHI.S3003

29. Carbajo A. Assessing the health impacts of climate change. Economics of climate change in Argentina. Environment and Development Series 159 ECLAC Santiago de Chile, 2015.

30. Agosti A, Zapata P Saghir N. The Bahamas after Hurricane Dorian. 2019, Oct 17. World Bank Blogs. https://blogs.worldbank.org/latinamerica/bahamas-after-hurricane-dorian.

31. Luber, G., K. Knowlton, J. Balbus, H. Frumkin, M. et al., 2014: Ch. 9: Human Health. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 220-256. doi:10.7930/J0PN93H5.

32. North CS, Pfefferbaum B. Mental health response to community disasters: a systematic review. JAMA. 2013;310(5):507-518. doi:10.1001/jama.2013.107799

33. 2018 WHO health and climate change survey report: tracking global progress. Geneva: World Health Organization; 2019 (WHO/CED/PHE/EPE/19.11). Licence: CC BY-NC-SA 3.0 IGO

34. Doubova SV, Guanais FC, Pérez-Cuevas R, et al. Attributes of patient-centered primary care associated with the public perception of good healthcare quality in Brazil, Colombia, Mexico, and El Salvador. Health Policy Plan 2016; 31:834-43.doi:10.1093/heapol/czv139

35. Guanais F, Doubova SV, Leslie HH, et al. Patient-Centered primary care, and self-rated health in 6 Latin American and Caribbean countries: analysis of a public opinion cross sectional survey. PLoS Med2018;15: e1002673.doi: 10.1371/journal.pmed.1002673.

36. Birhanu Z, Assefa T, Woldie M, et al. Determinants of satisfaction with healthcare provider interactions at health centres in central Ethiopia: a cross sectional study. BMC Health Serv Res2010;10: 78.doi:10.1186/1472-6963-10-78

37. Kruk ME, Gage AD, Arsenault C, et al. High-Quality health systems in the sustainable development goals era: time for a revolution. The Lancet Global Health2018;6: e1196-252. doi:10.1016/S2214-109X (18)30386-3

38. Ward V, Pinkey L, Fry G. Developing a framework for gathering and using Service user experiences to improve integrated Health and social care: The SUFFICE Framework. BMC Res Notes (2016) 9:437. DOI 10.1186/s13104-016-2230-0.

39. Jaramillo-Echeverri LG, Pinilla-Zuluaga CA, Duque-Hoyos MI. Patients' perception and communication with healthcare workers in the acute service of the Hospital of Caldas. Manizales (Colombia). Index de Enfermeria 2004; 13: 29-33

40. Lazcano-Ponce E, Angeles-Llerenas A, Alvarez-del Río A. Ethics and communication between physicians and their patients with cancer, HIV/AIDS, and rheumatoid arthritis in Mexico. Archives of Medical Research 2004;35: 66-75.

41. Kim MK, Blendon RJ, Benson JM. 2013. What is driving people's dissatisfaction with their own healthcare in 17 Latin American countries? Health Expectations 16: 155-63.

42. Guanais F, Regalia F, Perez-Cuevas R, Anaya M. From the patient. Experiences of primary healthcare in Latin America and the Caribbean. IDB 2018. https://publications.iadb.org/en/desde-el-paciente-experiencias-de-la-atencion-primaria-de-salud-en-america-latina-y-el-caribe.

43. Pan American Health Organization. 56th Directing Council. 70th Session of the WHO Regional Committee for the Americas. Plan of action on HEALTH WORKFORCE for universal access to health and universal health coverage 2018-2023. https://www.observatoriorh.org/sites/default/files/webfiles/fulltext/2018/CD56-10-s-PdA-RH.pdf

44. Lofters AK. The Brain Drain of healthcare workers: causes, solutions, and the example of Jamaica. Can J Public Health. 2012 Jul 18;103(5): e376-8.

45. Arroyo J, Hartz j, Lau M. HEALTHCARE WORKERS in health as of 2011. Evidence for decision making. Dirección General de Gestión del Desarrollo de PERSONAL SANITARIO. Observatorio Nacional de PERSONAL SANITARIO en Salud. Lima, Ministry of Health; 2011.

46. ECLAC. The COVID-19 pandemic is exacerbating the care crisis in Latin America and the Caribbean. https://repositorio.cepal.org/bitstream/handle/11362/45352/4/S2000260_en.pdf

47. Pelley E, Danoff A, Cooper DS, Becker C. Female Physicians, and the Future of Endocrinology. J Clin Endocrinol Metab. 2016;101(1):16-22. doi:10.1210/jc.2015-3436

48. Tessmer-Tuck JA, Rayburn WF. Roles of Obstetrician-Gynecologist Hospitalists with Changes in the Obstetrician-Gynecologist Workforce and Practice. Obstet Gynecol Clin North Am. 2015;42(3):447-456. doi: 10.1016/j.ogc.2015.05.004.

49. Economic Commission for Latin America and the Caribbean (ECLAC), Women's autonomy in changing economic scenarios (LC/CRM.14/3), Santiago, 2019. https://repositorio.cepal.org/bitstream/handle/11362/45037/S1900722_en.pdf?sequence=4&isAllowed=y

50. Boniol M, McIsaac M, Xu L, Wuliji T, Diallo K, Campbell J. Gender equity in the health workforce: analysis of 104 countries. Working paper 1. Geneva: World Health Organization; 2019 (WHO/HIS/HWF/Gender/WP1/2019.1). Licence: CC BY-NC-SA 3.0 IGO

51. Vaca I. Technical-professional education and labor inclusion for greater equality in Latin America and the Caribbean. ECLAC Seminar, March 14, 2019. https://www.cepal.org/sites/default/files/presentations/mesa_7_i_vaca_t.pdf

52. OSINSA. OSINSA research: How old are our healthcare workers. August 2015. https://www.osinsa.org/2015/08/25/investigacion-osinsa-que-edad-tienen-nuestros-trabajadores-de-la-aludel-estudio-desarrollado-por-el-osinsa-indago-en-las-edades-de-los-trabajadores-de-la-anidad-argentina/

53. National Institute of Statistics and Geography. Statistics on the occasion of the Physician's Day. National Data. https://www.inegi.org.mx/contenidos/saladeprensa/aproposito/2014/medico0.pdf

54. World Health Organization. Health Workforce. https://www.who.int/health-topics/health-wor-kforce#tab=tab_1.

55. Ministry of Health. Report on healthcare workers gaps by health service. Glosa 01, Letter i. Budget Law 2017

56. Economic Commission for Latin America and the Caribbean (ECLAC), Demographic Observatory, 2016 (LC/PUB.2017/3-P), Santiago, 2016.

57. Liu J, Goryakin Y, MaedaA, Brukner T, Schefler R. Global Health Workforce Labor Market Projections for 2030. Human Resources for Health. 2017; 15:11

58. World Health Organization. Health Workforce Requirements for Universal Health Coverage and the Sustainable Development Goals. Human Resources for Health Observer Series No 17. 2017.

59. World Health Organization. Strategy on Human Resources for Universal Access to Health and Universal Health Coverage160th Session of the Executive Committee. Washington, D.C., USA, 26-30 June 2017. https://iris.paho.org/bitstream/handle/10665.2/34198/CE160-18-e.df?sequence=1&isAllowed=y

60. PAHO. Press Note. Most countries in the Americas have sufficient healthcare workers but face challenges in distribution, migration, and training. https://www3.paho.org/hq/index.php?option=com_content&view=article&id=9146:2013-most-countries-sufficient-heal-thpersonnel-challenges-distribution-migration-training&Itemid=0&lang=en#gsc.tab=0

61. Carpio, Carmen, and Natalia Santiago Bench. 2015.The Health Workforce in Latin America and the Caribbean: An Analysis of Colombia, Costa Rica, Jamaica, Panama, Peru, and Uruguay. Directions in Development. Washington, DC: World Bank. doi:10.1596/978-1-4648-0594-3. https://openknowledge.worldbank.org/bitstream/handle/10986/22027/9781464805943.pdf

62. PAHO. Health Workers perception and migration in the Caribbean Region. Department of Health Systems and Services. November 2019

63. Sands S, Ingraham K, Salami B. Caribbean Nurse Migration - a scoping review- Human Resources for health 2020;18-19. https://doi.org/10.1186/s12960-020-00466-y

64. Scheffer MC, Guilloux AGA, Matijasevich A, Massenburg B, Saluja S, Alonso N. The state of the surgical workforce in Brazil. Surgery. 2017;161(2):556-561.

65. Rodriguez, A., Romero-Sandoval, A., Sandoval, B.A. et al. Medical specialist distributions in Ecuador: a geographical and temporal analysis of data from 2000 to 2017. BMC Health Serv Res 22, 671 (2022). https://doi.org/10.1186/s12913-022-08056-5.

66. Da Silva, Fernando Menezes. Transforming health professions education to advance toward universal health. InterAm J Med Health. 2018;1: e201801006

67. Lorenzoni L, Pinto M, Guanais F, Plaza T, Daniel F, Auraaen A. Health Systems Characteristics: A Survey of 21 Latin American and Caribbean Countries. OECD Health Working Paper No.111. DELSA/HEA/WD/HWP (2019)4.

68. Medeiros A, Waller D, Massuda A, Dantas G. Evaluating medical education regulation chan- ges in Brazil: workforce impact. Hum Resour Health (2021) 19:33. https://doi.org/10.1186/s12960-021-00580-5.

69. Reussi R. Undergraduate and graduate education in Latin America. Educ Med. 2018:19 (S1):1-3

70. Fajardo Dolci G, Santacruz Varela J, Contrera Toro IF, Yorio Nieto MA, Pichs García LA, Zambrana Ávila GW, et al. Training of general practitioners in Latin America: a challenge for universal health. Rev Panam Salud Publica. 2019;43: e83. https://doi .org/10.26633/RPSP.2019.83

71. Cassiani SHDB, Wilson LL, Mikael SSE, Morán-Peña L, Zarate-Grajales R, McCreary LL, et al. The situation of nursing education in Latin America and the Caribbean towards universal health. Rev. Latino-Am. Enfermagem. 2017;25: e2913. DOI: http://dx.doi.org/10.1590/1518-8345.2232.2913

72. Noriega L, Castillo M, Santolaya M. Training of specialists in Latin America. Role of Chilean universities. Educ Med. 2018;19(S1):25---30

73. Barajas-Ochoa A, Ramos-Remus A, Ramos-Gomez S, Barajas-Ochoa Z, et al., Desempeno de las escuelas de medicina en México: resultados del Examen Nacional para Aspirantes a Residencias Médicas. Salud pública Méx 61 (4) 22 Apr 2020Jul-Aug 2019 - https://doi.org/10.21149/10042

74. PAHO. Investing in the nursing workforce in the Region of the Americas. Infographic. https://iris.paho.org/handle/10665.2/55983.

75. https://qdd.oecd.org/Home/ApplyFilter

76. National Academies of Sciences, Engineering, and Medicine 2018. Improving Health Professio-nal Education and Practice Through Technology: Proceedings of a Workshop. Washington, DC: The National Academies Press. https://doi.org/10.17226/25072

77. Abreu-Hernández, Luis F, León-Bórquez, Ricardo, & García-Gutiérrez, José F. (2020). COVID-19 pandemic and medical education in Latin America. FEM: Journal of the Medical Education Foundation, 23(5), 237-242. Epub November 23, 2020.https://dx.doi.org/10.33588/ fem.235.1088

78. Papapanou M, Routsi E, Tsamakis K, et al Medical education challenges and innovations during COVID-19 pandemic Postgraduate Medical Journal Published Online First: 29 March 2021. doi:10.1136/postgradmedj-2021-140032

79. Rojas R. Needs of specialists in Geriatrics and Gerontology for the Costa Rican Social Security Fund. Training and Staffing. Projection 2008-2025. Centro de Desarrollo estratégico e información en salud y seguridad social. http://sites.bvsalud.org/gcPERSONAL_SANITARIO/es/repositorio/resource/?id=biblioref.referencesource.981841

80. IOM (Institute of Medicine). 2008. Retooling for an aging America: Building the healthcare workforce. Washington, DC: The National Academies Press

81. Siqueri CAS, Pereira GA, Sumida GT, Mafra ACCN, Bonfim D, Almeida LY, Monteiro CN. What are the implications of problem-solving capacity at Primary Healthcare in older adult health? Einstein (Sao Paulo). 2022 Jun 24;20: eGS6791. doi: 10.31744/einstein_journal/2022GS6791. PMID: 35766675; PMCID: PMC9239563.

82. Huenchuan S. Aging and public institutionality in Latin America and the Caribbean: concepts, methodologies and case studies. CELADE-Population Division of the Economic Commission for Latin America and the Caribbean (ECLAC) 2016.

83. Montes de Oca V, Rodriguez V, Helfer S. A Look at Aging: Where are several Latin American countries 15 years after the Madrid International Plan of Action? UNFPA 2017

84. Society on critical care medicine statistics. https://www.sccm.org/Communications/Criti-cal-Care-Statistics

85. Torres F. Latin America in intensive care. Salud con Lupa. https://saludconlupa.com/series/coronavirus/latin-america-in-intensive-care

86. Heinze-Martin G, Olmedo-Canchola VH, Bazán-Miranda G, Bernard-Fuentes NA, Guízar-Sán- chez DP. Physician specialists in Mexico. Gac Med Mex. 2018;154(3):342-351. doi: 10.24875/GMM.18003770. PMID: 30047941

87. Pan American Health Organization. The COVID-19 Healthcare Workers Study (HEROES): Regional Report from the Americas. Pan American Health Organization, 2022. https://iris.paho.org/bitstream/handle/10665.2/55972/PAHONMHMHCOVID-19220001_eng.pdf?sequence=1&isAllowed=

88. Urzúa A, Samaniego A, Caqueo-Urízar A, Zapata A, Irarrázaval M. Mental health in healthcare workers during the COVID-19 pandemic in Chile. Rev Med Chile. 2020:148(8):1121-1127. http://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0034-98872020000801121&lng=es

89. Becerra B, Becerra D, Quintanilla F. Job stress and mental health of healthcare workers in the context of the Coronavirus pandemic in Peru. Cuban Journal of General Comprehensive Medicine. 2021;37(Sup): E1481. http://www.revmgi.sld.cu/index.php/mgi/article/view/1481/396.

90. Pan American Health Organization. Mental Health and Covid-19

91. Pinto D. Listen to me, protect me, prepare me, support me and take care of me. Healthcare workers need more than applause. Blog Gente Saludable. https://blogs.iadb.org/salud/es/perso-nal-salud-aplausos-coronavirus

92. Secretariat of Health. Recomendaciones y estrategias generales para la protección y la atención a la salud mental del personal sanitario que opera en los centros COVID y otras instalacio- nes que prestan atención a los casos sospechosos o confirmados. Secretaría de Salud de México, 2020. https://coronavirus.gob.mx/wpcontent/uploads/2020/05/Recomendaciones_estrategias_generales_proteccion_proteccion_atencion_salud_mental_personal_sanitaro_2.pdf

93. Cantor F, McDouall J, Parra A, et al., Mental healthcare of healthcare workers during COVID-19: evidence-based recommendations and expert consensus. Revista Colombiana de Psiquiatría 2021;50(3):225-231. https://doi.org/10.1016/j.rcp.2021.02.007.

94. Suwantarat N, Apisarnthanarak A. Risks to healthcare workers with emerging diseases: lessons from MERS-CoV, Ebola, SARS, and avian flu. Curr Opin Infect Dis. 2015;28(4):349-361. doi:10.1097/QCO.0000000000000183.

95. Ran L, Chen X, Wang Y, Wu W, Zhang L, Tan X, Risk Factors of Healthcare Workers with Corona Virus Disease 2019: A Retrospective Cohort Study in a Designated Hospital of Wuhan in China, Clinical Infectious Diseases, , ciaa287, https://doi.org/10.1093/cid/ciaa287.

96. Mohanty A, Kabi A, Mohanty AP. Health problems in healthcare workers: A review. J Family Med Prim Care 2019; 8:2568-72.

97. Joseph B, Joseph M. The health of the healthcare workers. Indian J Occup Environ Med. 2016;20(2):71-72. doi:10.4103/0019-5278.197518.

98. Beauregard LP. Mexico seeks to hire 19,000 doctors and nurses in two weeks to address epidemic. El País. https://elpais.com/sociedad/2020-04-05/mexico-busca-con- tratar-19000-medicos-y-enfermeras-en-dos-semanas-para-atender-la-epidemia.html.

99. https://www.gov.br/pt-br/noticias/saude-e-vigilancia-sanitaria/2020/04/201co-brasil-conta-comigo201d-enables-students-da-saude-to-treat-no-combat-a-coronavirus.

100. Pan American Health Organization. Rapid Assessment of service delivery for NCDs during the COVID-19 pandemic in the Americas, 4 June 2020. IRIS Institutional Repository for Information Sharing. https://iris.paho.org/handle/10665.2/52250

101. Garcia H, Diaz P, Avila D, Cuzco M. Health Sector Reform and the health workforce. An Fac Med. 2015; 76:7-26.

102. Caldas de Almeida JM1. Mental health services development in Latin America and the Caribbean: achievements, barriers and facilitating factors. Int Health. 2013 Mar;5(1):15-8.

103. Pérez-Cuevas R, Contreras-Sánchez SE, Doubova SV, García-Saisó S, Sarabia-González O, Pacheco-Estrello P, Arias-Mendoza A. Gaps between supply and demand of acute myocardial infarction treatment in Mexico. Salud Publica Mex. 2020. https://doi.org/10.21149/11032

104. General Directorate of Quality and Education in Health. La atención del infarto agudo almio-cardio en México. Secretaría de Salud, Mexico 2016. http://www.calidad.salud.gob.mx/site/editorial/docs/atencion_infarto_agudo_miocardio_enMexico.pdf

105. Mathew A. Global Survey of Clinical Oncology. Journal of Global Oncology. 2018; 4:1-'5

106. Doubova SV, Knaul F, Borja V, Garcia-Saiso S, Zapata M, Pacheco P, Arreola H, Sarabia O. Pérez-Cuevas R. Access to pediatric cancer care treatment in Mexico: Responding to health system challenges and opportunities. Health Policy and Planning, 2019, 1-11. doi: 10.1093/ heapol/czz164.

107. Doubova SV, Ramirez-Sanchez C, Figueroa-Lara A, Perez-Cuevas R. Human resources for the care of patients with diabetes in family medicine units of the Mexican Social Security Institute. Salud Publica Mex 2013; 55:607-617.

108. Belizan M, Alonso J, Nejamis A, Caporale J, Copo M, Sanchez M, Rubinstein A, Irazola V. Barriers to hypertension and Diabetes management in primary healthcare in Argentina: qualitative research-based on a behavioral economics approach. TBM 2020; 10:741-750 doi: 10.1093/tbm/ibz040

109. Poblano O, Vieyra W, Galván Á, Fernández M, Rodríguez A, Saturno, Pedro. Quality and compliance with clinical practice guidelines for chronic noncommunicable diseases at the first level. Salud Pública de México, 2017; 59(2), 165-175. https://doi.org/10.21149/8285

110. Ministry of Health. Quality of Care Index for Diabetes in Mexico (ICAD). Results as of October 2021. http://www.tablerocronicassic-sinba.com/TableroICAD/ICAD

111. Nishtar S, Ralston J. Can human resources for health in the context of noncommunicable disease control be a lever for health system changes? Bull World Health Organ 2013; 91:895-896 doi: http://dx.doi.org/10.2471/BLT.13.118711

112. Nelson J, Tejerina L, Cafagna G, Ulrich A. Approach to digital transformation: guidelines and recommendations. Division of Social Protection and Health. Interamerican Development Bank. 2019

113. Triberti S, Savioni L, Sebri V, Pravettoni G. eHealth for improving quality of life in breast cancer patients: A systematic review. Cancer Treat Rev. 2019; 74:1-14. doi: 10.1016/j.ctrv.2019.01.003.

114. Compeau DR, Terry A. Connecting Medical Records: An Evaluation of Benefits and Challenges for Primary Care Practices. J Innov Health Inform. 2017;24(2):855. doi: 10.14236/jhi. v24i2.855.

115. Gardner C, Acharya T, Yach D. Technological and Social Innovation: A Unifying New Paradigm for Global Health. Health Affairs 26, no. 4 (2007): 1052-1061; 10.1377/hlthaff.26.4.1052.

116. Schade CP, Sullivan FM, de Lusignan S, Madeley J. e-Prescribing, efficiency, quality: lessons from the computerization of UK family practice. J Am Med Inform Assoc. 2006;13(5):470-5. doi: 10.1197/jamia.M2041. http://jamia.bmj.com/cgi/pmidlookup?view=long&pmid=16799129

117. Hall CS, Fottrell E, Wilkinson S, Byass P. Assessing the impact of mHealth interventions in low- and middle-income countries--what has been shown to work? Glob Health Action. 2014; 7:25606. doi:10.3402/gha. v7.25606.

118. Anticona C, Pajuelo M, Corre M, Malpartida H, Oberhelma R, Murphy L, Paz-Soldan V. Diagnostic Barriers, and innovations in rural areas. Insights from junior medical doctors on the frontlines of rural care in Peru. BMC Health Services Research (2015) 15:454. DOI 10.1186/s12913-015-1114-7.

119. OECD Health Outlook, Latin America and the Caribbean 2020. Medical Technologies. https://www.oecd-ilibrary.org/sites/924f7f5aes/index.html?itemId=/content/component/924f7f5a-es

120. Moldes JM, de Badiola FI, Vagni RL, Mercado P, Tuchbaum V, Machado MG, and López PJ. Pediatric Robotic Surgery in South America: Advantages and Difficulties in Program Implementation. Front. Pediatr. 2019,7:94. doi: 10.3389/fped.2019.00094

121. OECD/The World Bank (2020), Health Panorama: Latin America and the Caribbean 2020, OECD Publishing, Paris. https://doi.org/10.1787/740f9640-es

122. OECD Health systems characteristics survey. 2018 Latin-American Countries. Health Systems Characteristics Survey (oecd.org)

123. Jara P, Carcamo C, Leslie H, Laos D. Skills, perceptions, and time use in the Peruvian health sector. Universidad Peruana Cayetano Heredia. 2019.

124. Omachonu V. Einspruch N. Innovation in Healthcare Delivery Systems: A Conceptual Framework. The Innovation Journal: The Public Sector Innovation Journal, Volume 15(1), 2010, Article 2.

125. Kuhlmann E, Batenburg R, Dussault G. Researching the health workforce: a framework for action. European J of Public Health, 2019; 29 (Supp 4). ckz185.754, https://doi.org/10.1093/eurpub/ckz185.754

126. Spetz J, Cimiotti JP, Brunell ML. Improving collection and use of interprofessional health workforce data: Progress and peril. Nurs Outlook. 2016 Jul-Aug;64(4):377-84. doi: 10.1016/j. outlook.2016.03.001. Epub 2016 Mar 25

127. Dal Poz M, Varella T, Fehn A. The future of work of healthcare workers (specifically doctors and nurses) through the lens of technology in the LAC region. 2019. Paper commissioned by the IADB

128. Brazil. Ministry of Health. Secretaria de Gestão do Trabalho e da Educação na Saúde. Programa mais médicos - dois anos: mais saúde para os brasileiros / Ministério da Saúde, Secretaria de Gestão do Trabalho e da Educação na Saúde. - Brasília: Ministério da Saúde, 2015.

129. Ministry of Health. Subsecretaría de Redes Asistenciales. Informe de brechas de persona de salud por servicio de salud. https://www.minsal.cl/wpcontent/uploads/2015/08/Infor-me-Brechas-PERSONAL_SANITARIO-en-Sector-P%C3%BAblico_Marzo2016.pdf

130. Ministerial Resolution 176-2014/MINSA, Approving the Technical Guide for the Methodology for the Calculation of the Gaps of HEALTHCARE WORKERS in Health, for the First Level of Care Services.

131. Núñez M, Cuzco M, Peralta F. Technical guide for the estimation methodology of the gaps of HEALTHCARE WORKERS in health for the second and third level of care services. 1st edition. Lima: Ministry of Health; 2014

132. Ministry of Health. Vice-Ministry of Health Policies, Directorate of Healthcare workers Development. Plan de Gestión y Desarollo de Talento Humano en Salud. 2019-2023. https://rrhh.salud.gob.sv/files/webfiles/politicas/politica_nacional_desarrollo_rrhh_v2.pdf

133. Pan American Health Organization. 29th Pan American Sanitary Conference. 69th Session of the WHO Regional Committee for the Americas. Resolution CSP29.R15 HEALTH PERSONNEL Strategy for Universal Access to Health and Universal Health Coverage Washington DC. 2017

134. Pan American Health Organization. Regional Observatory of HEALTHCARE WORKERS for Health. https://www.observatoriorh.org

135. Pan American Health Organization. Healthcare workers Repository. http://sites.bvsalud.org/gcHealthPERSONAL_SANITARIO/en/repositorio

136. Espinosa V, de la Torre D, Acuña C, Cadena C. The HEALTHCARE WORKERS in health according to the new model of care in Ecuador. Rev Panam Salud Publica. 2017:41: e52.

137. Pereira LL, Santos LMP, Santos W, Oliveria A, Ratner D. Mais Médicos Program. Provision of medical doctors in rural, remote, and socially vulnerable areas of Brazil, 2013-2014. Rural and Remote Health. 2016; 16:3616. http://www.rrh.org.au

138. Kuhlmann E, Batenburg R, Dussault G. Researching the health workforce: a framework for action. European J of Public Health, 2019; 29 (Supp 4). ckz185.754, https://doi.org/10.1093/ eurpub/ckz185.754.

139. The Global Fund. Technical Report. Strategic support to HEALTH WORKERS for health. Geneva, 2018

140. Silberman P, Medina A, Bazan J, Lopez E, Dursi C. Planning and human talent management policies of the ministry of health of Argentina during the COVID-19 pandemic. Revista Argentina de Salud Pública 2020;12 Supl COVID-19: e11.

141. SAM Subregional Program for South America. PAHO. The Response to COVID-19 from Human Resources for Health: Exchange of Experiences among South American Countries. July 2020.

142. OECD (2016), Health Workforce Policies in OECD Countries: Right Jobs, Right Skills, Right Places, OECD Health Policy Studies, OECD Publishing, Paris, https://doi.org/10.1787/9789264239517-en.

143. Joshi R, Alim M, Kengne AP, Jan S, Maulik PK, et al. (2014) Task Shifting for Non-Communicable Disease Management in Low- and Middle-Income Countries - A Systematic Review. PLoS ONE 9(8): e103754. doi: 10.1371/journal.pone.0103754.

144. Hoeft T, Fortney J, Patel V, Unutzer J. Task-Sharing Approaches to Improve Mental Healthcare in Rural and Other Low-Resource Settings: A Systematic Review. The Journal of Rural Health; 2018; 34: 48-62.

145. Solís, K. and Guevara, G. (2015). Home visit program of the Costa Rican health system: guidelines for its improvement. Rev. Enfermería Actual en Costa Rica, 29, 1-18. DOI: http://dx.doi.org/10.15517/revenf.v0i29.19671

146. National Council for the Evaluation of Social Development Policy. Ficha de Monitoreo 2017-2018 IMSS-Prospera. http://www.imss.gob.mx/sites/all/statics/imssBienestar/evaluacionExterna/eval-2017-2018-Ficha-Monitoreo.pdf

147. OECD/The World Bank (2020), Health at a Glance: Latin America and the Caribbean 2020, OECD Publishing, Paris, https://doi.org/10.1787/6089164f-en.

148. Martinez-Gonzalez N, Tandjung R, Djalali S, Rosemann T. the impact of physician'nurse task shifting in primary care on the course of disease: a systematic review. Human Resources for Health (2015) 13:55. DOI 10.1186/s12960-015-0049-8

149. Maier C, Aiken L, Busse R. Nurses in advanced roles in primary care: Policy levers for implemen- tation. OECD Working Papers No. 98. https://dx.doi.org/10.1787/a8756593-en

150. International Council of Nurses. Guidelines on Advance Practice Nursing 2020. Geneva: ICN. 2020

151. Auerbach D, Staiger D, Buerhaus P. Growing ranks of advanced practice clinicians. Implications for the physician workforce. N Eng J Med 2018;378(25):2358-2360.

152. Bauer L, Bodenheimer T. Expanded roles of registered nurses in primary care delivery of the future. Nurs Outlook. 2017;65(5):624-632.

153. Honig J, Lindrud SD, Dohrn J. Moving towards universal health coverage: advanced practice nurse competencies. Rev. Latino-Am. Enfermagem. 2019;27: e3132. 2

154. Noseworthy J. The future of Care. Preserving the patient-physician relationship. Shattuck lecture. N Engl J Med. 2019;381(23): 2265-2269.

155. Busetto L, Luijkx K, Calciolari S, GonzaÂlez Ortiz LG, Vrijhoef HJM Exploration of workforce changes in integrated chronic care: Findings from an interactive and emergent research design. PLoS ONE 2017;12(12): e0187468. https://doi.org/10.1371/journal.pone.0187468.

156. Schot E, Tummers L, Noordegraaf M. Working on working together. A systematic review on how healthcare professionals contribute to interprofessional collaboration [published online ahead of print, 2019 Jul 22]. J Interprof Care. 2019;1-11.

157. Bridges J, Lucas G, Wiseman T, et al. Workforce characteristics and interventions associated with high quality care and support to older people with cancer: a systematic review. BMJ Open 2017;7: e016127.

158. Pérez-Cuevas R, Doubova S, Bazaldúa-Merino L, Reyes-Morales H, Martínez D, Karam R, Gamez C, Muñoz-Hernández O. A social health services model to promote active ageing in Mexico: design and evaluation of a pilot program. Ageing and Society, 2014.

159. Kunik ME, Mills WL, Amspoker AB, Cully JA, Kraus-Schuman C, Stanley M, Wilson NL. Expanding the geriatric mental health workforce through utilization of non-licensed providers. Aging Ment Health. 2017 Sep; 21(9):954-960.

160. Araya R, Stampini M. Task shifting and technology are game changers in facing mental health challenges. Healthy People Blog. March 27, 2023. https://blogs.iadb.org/salud/en/task-shifting-and-technology-are-game-changers-in-facing-mental-health-challenges/

161. Araujo de Carvalho I, Epping-Jordan J, Pot AM, Kelley E, Toro N, Thiyagarajan JA, Beard JR. Organizing integrated health-care services to meet older people's needs. Bull World Health Organ. 2017 Nov 1;95(11):756-763. doi: 10.2471/BLT.16.187617. Epub 2017 May 26.

162. Ministry of Health. National Health Program for the Elderly. MINSAL 2014.

163. World Health Organization. World report on aging and health. Ginebra 2015.

164. Back AL, Fromme EK, Meier DE. Training Clinicians with Communication Skills Needed to Match Medical Treatments to Patient Values J Am Geriatr Soc. 2019 May;67(S2): S435-S441.

165. Kelley D. From IDEO on 'Design Thinking', http://www.fastcodesign.com/1139331/ideos-da-vid-kelley-design-thinking

166. Roberts JP, et al. A design thinking framework for healthcare management and innovation. Healthcare (2016), http://dx.doi.org/10.1016/j.hjdsi.2015.12.002i

167. Van Der Cammen T, Albayrak A, Voute E, Molenbroek J. New Horizons in design for autonomous aging. Age and Ageing 2017; 46:11-17.

168. Altman M, Huang TT, Breland JY. Design Thinking in Healthcare. Prev Chronic Dis 2018; 15:180128.

169. McLaughlin JE, Wolcott, Hubbard D, Umstead K, Rider TR. A qualitative review of the design thinking framework in health professions education. BMC Med Educ. 2019 Apr 4;19(1):98. doi: 10.1186/s12909-019-1528-8. Author information:

170. Robert G, Cornewll J, Locok L, Purushotam A, Sturmey G, Gager M. Patients, and staff as codesigners of healthcare services. BMJ 2015;350: g7714.

171. Coleman k, Austin B, Brach C, Wagner E. Evidence on the Chronic Care Model in the New Millennium. Health Affairs, 28, no.1 (2009):75-85. http://content.healthaffairs.org/con-tent/28/1/75.full.html

172. Wagner EH. Chronic disease management: what will it take to improve care for chronic illness? DBS. 1998;1(1):2-4.

173. Yeoh, E.K. et al. (2018) Benefits and limitations of implementing Chronic Care Model (CCM) in primary care programs: a systematic review. International Journal of Cardiology, 258, pp. 279-288.

174. Nancarrow S, Roots A, Grace S, Moran A, Vanniekerk-Lyon K. Implementing large-scale work- force change: learning from 55 pilot sites of allied health workforce redesign in Queensland, Australia. Human Resources for Health 2013, 11:66 http://www.humanresources-health.com/content/11/1/66

175. You Y, Doubova S, Pinto-Masis D, Pérez-Cuevas R, Borja-Aburto V, Hubbard A. Application of machine learning methodology to assess the performance of DIABETIMSS program for patients with type 2 diabetes in family medicine clinics in Mexico. BMC Medical Informatics and Decision Making (2019) 19:221.

176. Han ER, Yeo S, Kim MJ, Lee YH, Park KH, Roh H. Medical education trends for future physicians in the era of advanced technology and artificial intelligence: an integrative review. BMC Med Educ. 2019 Dec 11;19(1): 460.

177. Schwartzstein R. Getting the Right Medical Students - Nature versus Nurture. N Engl J Med; 2015:372(17):1586-1587.

178. Pan American Health Organization. Interprofessional education in healthcare: improving human resources capacity to achieve universal health. Report of the meeting December 7-9, 2016. in Bogota, Colombia. Washington, D.C.: PAHO; 2017.

179. Fortuna CM, Dias BM, Laus AM, Mishima SM, Cassiani SHDB. Interprofessional health education in the Region of the Americas from the nursing perspective. Rev Panam Salud Publica. 2022;46: e69. https://doi.org/10.26633/RPSP.2022.69

180. Lindgren S, Gordon D. The role of the doctor and the competencies expected from doctor of the future. In Routledge International Handbook of Medical Education, 2016. World Fe- deration of Medical Education. https://wfme.org/home/projects/role-of-the-doctor/

181. Carroll N, Richardson I, Moloney M, O'Reilly P. Bridging healthcare education and technology solution development through experiential innovation. Health Technol. 2018; 8:255-261.

182. Joynes V, Fuller R. Legitimisation, personalisation, and maturation: Using the experiences of a compulsory mobile curriculum to reconceptualise mobile learning. Med Teach. 2016; 38(6), 621-627.

183. Rajaram A, Hickey Z, Patel N, Newbigging J, Wolfrom B. Training medical students and residents in the use of electronic health records: a systematic review of the literature. J Am Med Inform Assoc. 2020 Jan 1;27(1):175-180.

184. Department for Digital, Culture, Media, and Sport, 'The Digital Strategy', Gov.uk, 2017, www.gov.uk/government/publications/ukdigital-strategy.

185. PWC. Workforce of the future. The competing forces shaping 2030. https://www.pwc.com/gx/en/services/people-organisation/workforce-of-the-future/workforce-of-the-future-the-competing-forces-shaping-2030-pwc.pdf.

186. Curioso WH Building Capacity and Training for Digital Health: Challenges and Opportunities in Latin America J Med Internet Res 2019;21(12): e16513.

187. Italian Hospital of Buenos Aires. Master's Degree in Health Informatics. Syllabus. 2022. https://hiba.hospitalitaliano.org.ar/archivos/noticias_archivos/163/Maestrias_2023/163_Programa2023-MIS.pdf

188. Tejerina L, Orefice P. Digital transformation of health: 10 lessons from a case study. Blog Gente Saludable BID. Feb 21, 2022. https://blogs.iadb.org/salud/es/salud-digital-urucool/

189. Cafagna G. Aranco N, Ibarrarán P, Oliveri ML, Medellín N, Stampini M. Aging with care: attention to dependency in Latin America and the Caribbean. Inter-American Development Bank. 2019.

190. Benedetti, F, Acuna J, Fabiani B. Telecare: technological innovations for remote care. IDB Technical Note IDB-TN-2475.

191. Batsis JA, DiMilia PR, Seo LM, Fortuna KL, Kennedy MA, Blunt HB, Bagley PJ, Brooks J, Brooks E, Kim SY, Masutani RK, Bruce ML, Bartels SJ. Effectiveness of Ambulatory Telemedicine Care in Older Adults: A Systematic Review. J Am Geriatr Soc. 2019 Aug;67(8):1737-1749.

192. Bennett KA, Ong T, Verrall AM, Vitiello MV, Marcum ZA, Phelan EA. Project ECHOGeriatrics: training future primary care providers to meet the needs of older adults. J Grad Med Educ. 2018 Jun;10(3):311-315.

193. System of Care. Annual Report 2017, National Caregiving Board. Ministry of Social Development. Uruguay. http://www.sistemadecuidados.gub.uy/117932/investigaciones-del-siste-ma-de-cuidados

194. Cui X (1), Wei R (1), Gong L (1), Qi R (2), Zhao Z (1), Chen H (3), Song K(1), Abdulrahman AAA(3), Wang Y(3), Chen JZS(4), Chen S(1), Zhao Y(1), Gao X(3).Assessing the effectiveness of artificial intelligence methods for melanoma: A retrospective review. J Am Acad Dermatol. 2019 Nov;81(5):1176-1180. doi: 10.1016/j.jaad.2019.06.042. epub 2019 Jun 27.

195. Secretary of Health of Jalisco. Cost-Benefit Study of the systematic screening of diabetic retinopathy supported by Artificial Intelligence in the State of Jalisco, based on the RETINA-IA use case. Inter-American Development Bank. 2023. Technical note in press.

196. D'Souza M, Gendreau J, Feng A, Kim LH, Ho AL, Veeravagu A. Robotic-Assisted Spine Surgery: History, Efficacy, Cost, And Future Trends [published correction appears in Robot Surg. 2019 Dec 23;6:25]. Robot Surg. 2019; 6:9-23. Published 2019 Nov 7.

197. Romero M. The field of surgery in Latin America continues evolving. https://www.linkedin.com/pulse/field-surgery-latin-america-continues-evolving-marianarome-ro-roy/?trk=pul-se-article_more-articles_related-content-card

198. Araujo r, Benevenuto D, Zilberstein B, Sallum R, Aguiar s, Cavazzola L, Nacul M, Melani A, Tomasich F. Overfiew and perspectives about the robotic surgical certification process in Brazil: the new statement and a national web survey. Rev col Bras 47:2020. https://doi.org/10.1590/0100-6991e-20202714

199. Bagolle A, Casco M, Nelson J, orifice P, Raygada G, Tejerina L. The Golden Opportunity of Digital Health for Latin America and The Caribbean. Inter-American Development Bank. 2022.

200. Vantara H. Kalakota R. Transform healthcare: a data-driven strategy for digital transformation. https://www.hitachivantara.com/en-us/pdfd/white-paper/digitaltransformation-of-health- care-industry-liquid-hub-whitepaper.pdf

201. Tan SS, Goonawardene N. Internet Health Information Seeking and the Patient-Physician Relationship: A Systematic Review. J Med Internet Res. 2017;19(1): e9. Published 2017 Jan 19.

202. Topol E. The patient will see you now: the future of medicine is in your hands. Basic Books. New York 2015.

203. Tan SS, Goonawardene N. Internet Health Information Seeking and the Patient-Physician Relationship: A Systematic Review. J Med Internet Res. 2017;19(1): e9. Published 2017 Jan 19.

204. Lewis MA, Dicker AP. social media and Oncology: The Past, Present, and Future of Electronic Communication Between Physician and Patient. Semin Oncol. 2015;42(5):764-771.

205. Langford AT, Roberts T, Gupta J, Orellana KT, Loeb S. Impact of the Internet on Patient-Phy- sician Communication. Eur Urol Focus. 2020;6(3):440-444.

206. Majumder S, Deen J. Smartphone sensors for Health monitoring and diagnosis. Sensors 2019, 19, 2164; doi:10.3390/s19092164. www.mdpi.com/journal/sensors

207. Doubova SV, Roze S, Ferreira-Hermosillo A, et al. Cost-effectiveness of the use of the continuous subcutaneous insulin infusion pump versus daily multiple injections in type 1 diabetes adult patients at the Mexican Institute of Social Security. Cost Eff Resour Alloc. 2019; 17:19. Published 2019 Sep 3. 2

208. Ruelas E, Alonso A. Health futures in Mexico 2050. General Health Council. Secretaría de Salud México, 2010.

209. Cruz Y, Fuertes N, Kang M, Robles M, Shady N, Zuluaga D. The future of work in Latin America and the Caribbean. Education and Health: the sectors of the future? www.iadb.org/futureofwork

210. Murphy G, Birch St, MacKensie A, Rigby J. Simulating future supply of and requirements for human resources for health in high-income OECD countries. Human Resources for Health; 2016;14:77 DOI 10.1186/s12960-016-0168-x

211. Parker WJ. The moral imperative of reproductive rights, health, and justice. Best Pract Res Clin Obstet Gynaecol. 2020 Jan; 62:3-10. doi: 10.1016/j.bpobgyn.2019.07.006. Epub 2019 Jul 29. PMID: 31540808.

212. Ethics Committee of the American Society for Reproductive Medicine. Electronic address: asrm@asrm.org. Access to fertility services by transgender and nonbinary persons: an Ethics Committee opinion. Fertil Steril. 2021 Apr;115(4):874-878. doi: 10.1016/j.fertnstert.2021.01.049. Epub 2021 Feb 23. PMID: 33632473.

213. Churchill, Larry R., King, Nancy M. P., and Henderson, Gail E., "The future of bioethics: it shouldn't take a pandemic," Hastings Center Report 50, no. 3 (2020): 54-56. 3

214. Langins M, Borgermans L. Strengthening a competent health workforces for the provision of coordinated/integrated health services. Working document. World Health Organization Regional Office Europe. 2015.

215. Drigas A, Papoutsi C. emotional intelligence as an important asset for HR in organizations: leaders and employees. Int Jorunal of Advanced Corporate learning. 2019 April. DOI: 10.3991/ ijac. v12i1.9637

216. Sturgess G. Skills vs Competencies. What's the Difference? Talent Align. Sept. 2012. https://www.talentalign.com/skills-vs-competencies-whats-the-difference/

217. Pavón, F. (2018). "Workers with digital skills wanted". Blog Factor Trabajo. May 31, 2018. Available at https://blogs.iadb.org/trabajo/es/se-buscantrabajadores-con-habilidades-digitales/ [Accessed: January, 2020].

218. Antwi M, Mruganka K. Change Management in healthcare. The Monieson Centre for Business in Healthcare. Queens School of Business. 2014. https://smith.queensu.ca/centres/monieson/knowledge_articles/files/Change%20Management%20in%20Healthcare%20-%20Lit%20Review%20-%20AP%20FINAL.pdf

219. Thomas J, Gilbert T, Thompson C. Preparing the future workforce for healthcare in Australia. Future Hospital Journal 2017 Vol 4, No 1: 67-71

220. Arnsten AFT, Shanafelt T. Physician Distress and Burnout: The Neurobiological Perspective. Mayo Clin Proc. 2021 Mar;96(3):763-769. doi: 10.1016/j.mayocp.2020.12.027. PMID: 33673923; PMCID: PMC7944649.

221. Li Y, Scherer N, Felix L, Kuper H. Prevalence of depression, anxiety, and post-traumatic stress disorder in healthcare workers during the COVID-19 pandemic: A systematic review and meta-analysis. PLoS One. 2021 Mar 10;16(3): e0246454. doi: 10.1371/journal.pone.0246454. PMID: 33690641; PMCID: PMC7946321.

222. Mateo M, Rucci G. The future is already here. Cross-cutting skills in Latin America and the Caribbean in the 21st Century. Inter-American Development Bank. 2019

223. Maeda A, Socha-Dietrich K. Skills for the Future Health Workforce: Preparing Health Professionals for People-Centred Care. OECD Health Working Paper No. 124. January 2021.

224. Archibald M. Futurism in nursing: Technology, robotics, and the fundamentals of care. J of Clinical Nursing. 2018:

225. The Topol Review: Preparing the Healthcare Workforce to Deliver the Digital Future. The NHS Constitution. 2019. [2020-10-08]. https://topol.hee.nhs.uk/

226. Nazeha N, Pavagadhi D, Kyaw BM, Car J, Jimenez G, Tudor Car L. a Digitally Competent Health Workforce: Scoping Review of Educational Frameworks. J Med Internet Res. 2020 Nov 5;22(11): e22706. doi: 10.2196/22706. PMID: 33151152; PMCID: PMC7677019.

227. Vimalananda VG, Gupte G, Seraj SM, et al. electronic consultations (e-consults) to improve access to specialty care: a systematic review and narrative synthesis. J Telemed Telecare. 2015;21(6):323-330.

228. Esmaeil Zadeh P, Tremblay MC. A review of the literature and proposed classifica-e tion on e-prescribing: Functions, assimilation stages, benefits, concerns, and risks. Res Social Adm Pharm. 2016;12(1):1-19.

229. Kitsiou S, Paré G, Jaana M. Effects of home telemonitoring interventions on patients with chronic heart failure: an overview of systematic reviews. J Med Internet Res. 2015;17(3): e63.4

230. Lee JY, Lee SWH. Telemedicine Cost-Effectiveness for Diabetes Management: A Systematic Review. Diabetes Technol Ther. 2018 Jul;20(7):492-500. doi: 10.1089/dia.2018.0098. Epub 2018 May 29. PMID: 29812965.

231. Jiang X, Ming WK, You JH. The Cost-Effectiveness of Digital Health Interventions on the Management of Cardiovascular Diseases: Systematic Review. J Med Internet Res. 2019 Jun 17;21(6): e13166. doi: 10.2196/13166. PMID: 31210136; PMCID: PMC6601257.

232. Camacho-Leon G, Faytong-Haro M, Carrera K, Molero M, Melean F, Reyes Y, Mautong H, De La Hoz I, Cherrez-Ojeda I. A Narrative Review of Telemedicine in Latin America during the COVID-19 Pandemic. Healthcare (Basel). 2022 Jul 22;10(8):1361. doi: 10.3390/healthcare10081361. PMID: 35893183; PMCID: PMC9330433.

233. World Health Organization. WHO Compendium of Innovative Health Technologies for Low Resource settings, 2011-2014. Assistive devices, eHealth solutions, medical devices, other technologies, Technologies for outbreaks.

234. Emmelkamp PMG, Meyerbröker K. Virtual Reality Therapy in Mental Health. Annu Rev Clin Psychol. 2021 May 7; 17:495-519. doi: 10.1146/annurev-clinpsy-081219-115923. Epub 2021 Feb 19. PMID: 33606946.

235. Zavala AM, Day GE, Plummer D, Bamford-Wade A. Decision-making under pressure: medical errors in uncertain and dynamic environments. Aust Health Rev. 2018 Aug;42(4):395-402.

236. Bhise V, Rajan SS, Sittig DF, Morgan RO, Chaudhary P, Singh H. Defining and Measuring Diagnostic Uncertainty in Medicine: A Systematic Review. J Gen Intern Med. 2018 Jan;33(1):103-115 Epub 2017 Sep 21. PMID: 28936618; PMCID: PMC5756158.

237. Berger Z. Navigating the unknown: shared decision-making in the face of uncertainty. J Gen Intern Med. 2015 May;30(5):675-8. doi: 10.1007/s11606-014-3074-8. PMID: 25536912; PMCID: PMC4395589.

238. Miller DD, Brown EW. Artificial Intelligence in Medical Practice: the Question to the Answer? Am J Med. 2018;131(2):129-133.

239. Meskó B. The Guide to the Future of Medicine Technology and the Human Touch. Webicina KFt. 2017

240. Kompa B, Snoek J, Beam AL. Second opinion needed: communicating uncertainty in me- dical machine learning. NPJ Digit Med. 2021 Jan 5;4(1):4. doi: 10.1038/s41746-020-00367-3. PMID: 33402680; PMCID: PMC7785732.

241. Verma, Virendra & Verma, Savita. Machine learning applications in healthcare sector: An overview. Materials Today: Proceedings. 2021;57. 10.1016/j.matpr.2021.12.101.

242. Handelman GS, Kok HK, Chandra RV, Razavi AH, Lee MJ, Asadi H. eDoctor: machine learning and the future of medicine. J Intern Med. 2018 Dec;284(6):603-619. doi: 10.1111/joim.12822. Epub 2018 Sep 3. PMID: 30102808.

243. You Y, Doubova SV, Pinto-Masis DM, Pérez-Cuevas R, Borja V, Hubbard A. Application of machine learning methodology to assess performance of DIABETIMSS program for patients with type 2 diabetes in family medicine clinics in Mexico. BMC Medical Informatics and Decision Making. 2019; 19:221

244. Raja JM, Elsakr C, Roman S, Cave B, Pour-Ghaz I, Nanda A, Maturana M, Khouzam RN. Apple Watch, Wearables, and Heart Rhythm: where do we stand? Ann Transl Med. 2019 Sep;7(17):417.

245. McQuate S. Alexa, do I have an irregular heart rhythm? First AI system for contactless monitoring of heart rhythm using smart speakers. UW News. https://www.washington.edu/news/2021/03/09/first-ai-system-for-contactless-monitoring-of-heart-rhythmus-ing-smart-speakers/

246. Kuma D. Genes, Genetics and Human Genomics in

247. Wright C, Middleton A, Parker M. Ethical, legal, and social issues in clinical genomics.


IDB
Improving lives