New Health Technologies and Health Workforce in Developing Economies

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Abstract

This paper focuses on the importance of human health resources in relation to current and future trends in health. It is based on syntheses of reports, publications and economic development processes related to the increasing needs for skilled human resources in health systems that are under both high demand but also under the requirements of new health technologies. A special emphasis is placed on developing countries where series of constraints could lead to limit the provision of access to health care under shortage of skilled labor. The human resources related risks at both levels of developed and developing economies are also discussed even though emergent and developed countries have generated new instruments to limit the negative effects of these constraints. Finally, if the expansion of access to new health technologies could be achieved within the world global health system framework, requirements of increasingly needed human resources and skills are shown.

Keywords: Medical Human Resources-Medical Technologies-Density of Medical Personnel-Global Health Systems.

JEL: I130, P520, J240

Introduction

Nowadays, the world is experiencing a demographic boom that is accompanied by the expansion of population needs (UN, 2010). This is more accentuated in developing countries where more efforts are necessary to sustain the induced growing demands (Bloom et al., 2001). Health is among the major needs to be satisfied. Advanced technologies are means that are increasingly accompanying new offers for on-going and future health systems. In this context, health systems include all the processes from health diagnosis to treatment and monitoring. They also account for medical equipment, pharmaceuticals, biotechnologies and nanotechnologies among others. Nutrition and environment are among the elements included in the enlarged integrated health systems as they can prevent health degradation and health problems. All these trends necessitate a quantitative size of the human resources needed but also a qualitative side that relates to the mobilization and use of increasingly sophisticated technologies and knowledge.

This paper recognizes that advanced technologies have current and promising impacts on both populations of developed and developing economies. But, in developing countries, health technologies are subject to different hurdles that limit their impacts and reduce their accessibility. These constraints lead to different sources of failures including risks and uncertainty, anti-commons, the state of the on-going research and development (R&D) gaps. In addition, the need for highly qualified medical human resources is pressured by emigration and mobility that accentuate shortages in quantity and in up to date knowledge (Heller, 1998; Gutam et al., 2010 and WHO, 2000). It is recognized also that human resources are major players in this domain. Local health addresses the issues of local specific health problems (neglected diseases) and diseases that are not generally

addressed by the global health system (Ghadar and Hardy, 2006). Qualified human resources are increasingly becoming crucial given these constraints, the advancement of technologies and their potential positive impacts on health. This is aggravated by the emigration of medical staff from developing to developed economies (Driouchi and Kadiri, 2010; Rutten, 2007). The latter limitation is related to the risks and uncertainties faced by the overall chain of applying new technologies and new discoveries to human health with human resources playing an important role. There are different types of risks and uncertainties faced by the populations with limitations in the area of safety and anticipation of sources of new hazards. In this area, developed economies can engage quicker than developing economies in identifying new sources of risks, safety nets with the required means to engage in further compensatory mechanisms. The recent cases of some pharmaceuticals with lethal side effects provide examples about the level of responses in both types of economies. Again, in all these stages, qualified human resources are essential.

The first part of this paper looks at global trends taking place in world human resources in health systems. The second part focuses on the major factors affecting the health workforce while the last part is devoted to analyzing the constraints to health and impacts on its human resources.

I. Global Trends in World Health Workforce

The economic and social issues related to medical doctors and health workforce in general are important for every economy and context. There are consequently series of questions that could be of relevance to the issue of human resources and mainly to medical doctors. These issues are expressed through the existence of relatively universal

shortage in both numbers and quality. These latter vary with different specialties and with the extent of the introduction of advanced technologies. Continuous new needs for medication are also putting further pressure on heath institutions and medical doctors. The acquisition of new technologies both general and specific to health besides the continuous adjustments in medical education and research, the procedures for hiring and assessing medical workforce besides the efficiency, professionalism and the freedom of medical services are major means for retention and adjustments on the supply side.

The global trends taking place in the health system worldwide and that are focused on larger demands for health care and advanced technologies do impose higher quantitative and qualitative pressures on human resources.

1. Worldwide New Health Technologies & Human Resources in Health

This is to show how advanced new technologies are changing the performance and the higher success rates of the Health Care Systems (HCS) but also imposing new requirements in human resources. The 2006 report of the World Health Organization (WHO, 2006) has already underlined the magnitude and extent of the importance of qualified human resources in all world health systems but especially in low income countries. Basic questions related to human resources in health are addressed in this important document. The report has referred to the necessity of "working together to ensure access to a motivated, skilled and supported health worker by every person in every village" (page XV).

But, the above study shows that sufficient financial resources and technologies need to be supported by the existing and future skilled workforce. As a labor intensive industry, the

health system requires more and more human resources with the talents and values appropriate for a better provision of health care. This workforce is also necessary for ensuring advances in the health care system through research and development.

If the success rates relative to previous technologies of the HCS are already known, the new requirements and burden placed on the HCS need to be emphasized. As new technologies involve intensive R&D, the advanced new technologies are most of the time provided by private organizations and universities where human resources play an important role. The level of sophistication of heath supplies, technologies and research necessitate higher sophistication in human skills and knowledge. This consequently imposes higher levels of knowledge in order to be fully beneficial to individuals and groups. These trends have been materializing most of the time into high costs of services that are not all the time accessible to public and free health systems. This has been generating over time health paying systems but also the full involvement of private health providers. This has also promoted different economies to adopt different formulas of social health coverage and private insurance systems to support the financially overwhelming health systems. These different elements are discussed in the following parts of this first section. Cases studies and examples are also provided to show the magnitude and extent of advanced new technologies in the world HCS.

2. Impulse from New Technologies and Human Resource Requirements

The World Health Organization (2010) defines HCS as the mechanisms that support health and provide health services. These services are not uniquely provided by machines but by increasingly knowledgeable human resources. As such, and with reference to both preventive and curative medicine, some authors include also the health

environment and account also for nutrition and other preventive means. The current and future HCS is known to be intensively requiring higher skills given the types of advanced technologies that are progressively involved. This has for sure generated and is expected to develop new HCS that need increasing financial, equipments and qualified human resources.

New technologies in the field of health are referred to as medical technologies. The Office of Technological Assessment (1982) recognized technology as drugs, devices, medical and surgical procedures used in medical care and organizational and supportive systems through which care is provided. But, some authors have recognized early enough, the major positive and negative implications of the technological changes in health care.

Through ages but mainly during the last few years, new technologies have been applied with more or less success to solve the biggest health problems of the populations. Scientific and technological development is saving countless number of lives and billions of dollars each year. Thompson and Tebbens (2006) claim that vaccine against polio saved, for US alone, around $180 billion in the past 50 years. Health threats are constant and new technologies allow diagnosis, awareness, cures and therapies. A good example of those threats is HIV. The world was unaware of it 30 years ago and now, it is affecting 33 million people globally with 2.7 million infections each year (UNAIDS, 2008).

Health does not benefit intuitively from new technologies and scientific advances. Crossing the bridge between new technologies and health care is subject to a complex process starting with research, development and regulatory process to market

introduction. According to FDA (2006), an average of eight to nine years is needed to test a drug before it is launched to public and even more for vaccines. These trends have been accentuating the roles of human resources and the skills needed at all levels of HCS, in all countries and globally.

Branciard, A. (2013) develops new means that could lead to open medical research focusing on pharmaceuticals for developing countries. The open innovation system suggested in this paper addresses the issue of the lagging R&D in most developing economies. Such important initiative could reduce the paradox in R&D with regard to local epidemics but requires more human resources that include larger number of medical doctors.

3. The Increasing Involvement of the Private Sector

As said earlier, the introduction and development of advanced new technologies in health systems have induced further involvement of the private sector. This involvement is present in all areas of health, such as medical devices, pharmaceuticals and ways to perform surgery (Rettig, 1994), but also in the health system as a whole with the increasing presence of the private sector as a source of financing and in the system's organization and institutions.

The increasing involvement of the private sector comes as a response to the growing cost of health care and the need for trained doctors and specialists to cope with the ever changing technologies. Prior literature such as Berndt et al., (1999) and Cutler et al., (1999) identified that advances in medical technology increases the health costs such as costs of R&D, production costs or costs related to training technicians. In the US, annual

costs rose from $297 per individual in 1970 to $3632 in the late 90s (Cowan et al., 1999). The public sector alone could not bear the increase in expenditures, especially in developing countries, thus, the intervention of the private sector was vital.

The increase in the health care bill introduced new HCS combining public and private sector. New HCS should enhance health care conditions without bringing more tax payments. In some countries, public health insurance is not applicable to population earning a high monthly income. In others, private insurance is complementary to the public one as some services and interventions are requiring copayments. The global society understood the importance of the private sector and put encouragement and incentive mechanisms to stimulate research and technology development.

The emergence of the private sector in the area of health care has been creating new challenges to HCS but mainly to different categories of the human resources operating in this sector but also in public hospitals and laboratories. Furthermore, as health care costs increase, further managerial and planning tools are needed. These include the development of new ways to manage human resources.

4. Enlargement of Prevention and Provision of public goods

This dimension is increasingly occupying a major role in the daily life of individuals and households in different economies with the increasing role of qualified medical work in the provision and communication of all preventive measures and health discipline. While the ingredients related to nutrition have been increasingly linked with health issues, further emphasis on the food and drink intake have been developing in relation to specific health hazards and the reduction of their risks (WHO, 2010). New

attitudes and perceptions of health impacts of food emerged while new technologies have been promoting further access to more naturally and biologically based agriculture and nutrition. Another development is related to the link between health and the living environment. Exercising and sports have been promoted as means to ensure prevention from health hazards. Addictions such as smoking have been recognized most of the time as sources of health complications that can lead to handicaps and death. Safer environment with minimal air, water and earth pollutions have been highly recognized as offering the best health conditions. The relationship between good nutrition, zero addiction with absence of liquid, solid and gas pollutions and noise has been further stressed by health professionals as the major source of prevention against health risks (WHO, 2010). Of course, vaccinations and other biological means have been recognized as important means for prevention. While specific recommendations can be provided by health professionals to different patients to help promote their health status, many services have been provided as public goods in different economies. Media and communication means are playing an increasingly important role in communicating and informing the public about the overall environmental hazards but also about any potential epidemics.

5. Technology Dependent Diagnoses and Curative Systems

The world health system has been progressively benefiting from the contribution of the new technologies. This is expressed at all the levels of the health chain but mainly at the level of health service delivery. Medical professionals continuously have access to new equipments and devices at the diagnosis and treatment levels. These equipments and devices as well as other health services are directly related to the advances in information

and communication technologies (ICT), microelectronics, nanotechnologies and biotechnologies but mainly to knowledgeable human resources.

ICT use is nowadays predominant in most of the sectors. It starts from using communication means such as simple e-mails or complex integrated systems. As applied to health and HCS, ICT is used in infrastructure, administration and especially clinically. Besides communication between HCS components and facilitating its management, ICT is used in electronic monitoring and prescribing, result reporting to laboratories, and health recording and archiving (MedPac, 2004). In nanotechnology and biotechnologies, new technologies allow going up the scale of molecules, proteins and nucleic acids. Nano-drugs and nano-devices opened new ways for innovative therapies and curative systems through genome sequencing or tissues engineering.

6. Quantitative Implications on the Health Workforce

WHO (2006) estimates a total of 59.2 million full-time paid health workers worldwide. These human resources operate in health enterprises primary focused on health care provision but also in allied organizations. According to the same source, health service providers represent two thirds while workers in management constitute the remaining third of the global health workforce. Kent, Chopra, Dal Poz and Bennett (2010) consider that human resources account for approximately 70% of recurrent expenditure in most health systems. As it can be observed from the appendices, developed economies have higher numbers of doctors, pharmacists and other health workers. This is also expressed in the density measured per 1000 population. But even with higher figures, the numbers are not that high compared to increasing needs of the populations and to the requirements imposed by advanced health technologies.

Developing economies even with major variables do not exhibit satisfactory figures for both total and density of health workforce.

Kent, Chopra, Dal Poz and Bennett (2010) show that since human resources account for approximately 70% of recurrent expenditure in most health systems, inadequate human resource training, regulation, distribution and management can have enormous implications. Many low- and middle-income countries (LMICs), particularly in sub-Saharan Africa, suffer from both a shortage of health-care providers and poor distribution of providers within the country. These problems are exacerbated by deficiencies in skill mixes and poor physical and managerial infrastructure. Moreover, the failure of health system reforms has been linked to the failure to strengthen policy, planning and management of human resources for health (HRH) early in the process. These trends are related also to the interdependencies that exist between different medical specializations and then to the interferences among different health specialists (ADA, 2006).

Murray, S.A. and Osman, H.(2012) show that several challenges are facing healthcare and where accounting for palliative practice is likely to have series of benefits. But, shortages in the human resources taking care in palliative medicine do negatively affect the health of patients and their families. This means that when accounting for medical specialties, the shortage can even be worse.

While some authors place emphasis on shortages of medical doctors, others are explaining emigration of medical doctors because of their excess. This is the case of Akl et al. (2012). These authors consider that Lebanon is increasing its capacity of medical education with opening of three new private medical schools since 2000 that comes to

seven medical schools in total. To these authors, in relation to globalization, physician Lebanese workforce is attracted by migration to the higher-income countries mainly Gulf countries, U.K., Canada, USA and Australia. About 40% of Lebanese graduated physicians during the last 25 years are working in the USA. A survey of Lebanese medical school graduates shows that 96% have the intention to work abroad for the main reason of saturation of local market job.

But, for the same country, other publications such as that of Alameddine et al. (2012) show in a study of primary health care centers in Lebanon represent a rare attempt in investigation of primary healthcare (PHC), **health human resources (HHR)** characteristics of work, level of burnout and likelihood and the factors with staff retention at PHC in these Lebanese centers.

While the shortage affects developing economies, developed countries as well are concerned. This explains the directions of migrations to developed economies, mainly to USA, EU and Australia. Years 2011, 2012 and 2013 have been witnessing larger discussions of the shortage of medical doctors in these economies.

Portugal is an example of EU countries affected by shortages of medical doctors. Russo et al. (2012) investigate the localization of national and international physicians in Portugal in order to understand the factors of the geographical gaps left by national doctors in a given country and how to help the policy makers in decisions for influencing physicians. In 2008, they were 39,473 physicians in Portugal, with 51.1% male, and 40.2% between 41 and 55 years of age, the majorities are from Portugal (90.5%) and the others are from Spain, Brazil and from some African countries. For these foreigner

physicians and mainly older men prefer living outside metropolitan areas as well the case for Spanish and Brazilian contrary to those from African nationalities that appears preferring Lisbon and Oporto. Decisions related to physicians, both national and foreigners, localization need to set up policies in the way to find the equilibrium medical services over all the geographical areas of any country.

Blacklock, et al. (2012), target the problem that can be presented in the poor countries from the migration of medical doctors to developed countries to fill the domestic shortages. In the UK, medical professional coming from Africa and south Asia changed from 3105 in 2001 to 7343 in 2003, where the National Health Service (NHS) set the 2000 NHS Plan related to ethical guidance to avoid massive recruitment of medical doctors from poor countries which was really effective mainly during the period of 2001-2004. Changes in the UK's immigration laws and bilateral agreements had positive impact in reduction of migration of doctors, now just about 4000 doctors come to UK a year from some African and south Asian and less developed European Countries.

Shankar & Thapa (2012) express in their study of Nepal, the perceptions of medical students to work in the rural areas after graduation. Until 2011 Nepal has 18 medical schools with 14 in the private sector. On the basis of a survey of 200 students, the majority is financing studies and most of them are from urban areas.72.4 % from interviewed from first and second grade say that they will work after graduation in governmental and nongovernmental sectors, 43% of medical students inform that the actual medical system is not preparing them adequately for work in the rural areas. Other students say that working in the rural areas seems difficult due to inadequate facilities, low salary, less security, problems with their professional development, less equipment in

health centers, decreased contact with family and difficulties in communicating with an illiterate, rural population. But in general, the majority of students are favorable to work in rural areas with improving conditions and facilities in these rural centers.

Ashmore (2013) discuss about distribution of health worker between public and private sectors in South Africa. The article tries to find reasons for within-country migration. The public hospitals are offering some attractive reasons to work in, such as offering team environment, academic opportunities, and self-feeling 'needed' and 'relevant', but all these incentives still insufficient for specialists looking for more opportunities in the private sector. These include the financial incentives and better conditions than in the public sector.

Amini et al. (2012) discuss about the ways to improve the quality of medical research in the Eastern Mediterranean Region and the set up of priorities in the medical education research in this region. Among these priorities, five are well requested; training physicians to be effective teachers; community-driven models for curriculum development; clinical teaching models; education about professionalism and ethics; and education for evidence-based medicine

Kinfu (2013) noticed that the South African health sector still facing challenges in terms of none balance between health resources that is increasing and the lack of improvement in inter-sectoral policy environment. A study is taken to measure the performance of the health sector in South Africa, where the results show that eight of the 52 districts in the country had an efficiency score of below 60%, and in four of these, the score was below 50%. The Technical inefficiency was related to HIV prevalence and illiteracy rates.

Technical Efficiency in the country was about 80%. Recommendations are made to invest more in additional resources in localities where the services are inadequate.

Oikelome & Healy (2012) took the example of medical graduates in the UK and the overseas, they put as well the accent on the inequalities between gender in migration of medical workers and carrier perceptions where the necessity to analyze the factors leading disparities and to set up policies taking into consideration particularities of women and men.

Wang Shaolin (2010) considers that migration has become an important feature of health labor markets due to the global shortage of health professionals. To this author, there is a major need for examining the economic influences on and impacts of the migration of health professionals. For that, the author incorporates features related to the characteristics of human resources into previous models to examine factors that influence the scale and skill composition of the migration flow of medical doctors mainly dentists.

Scheffler et al. (2011) discuss the shortages in low and middle economies in terms of workers in mental health centers and funds allocated to these centers. The shortage was of 1.18 million workers in 2005, with 55,000 psychiatrists, 628,000 nurses in mental health settings and 493,000 psychosocial care providers. The annual wage bill needed to remove this shortage would be about US$4.4 billion (2009 US$).

Soucat, Scheffler and Ghebreyesus (2013) introduce both a promising framework accounting for labor markets for health workers and the analysis of the health system in African countries. Series of chapters in this book explain the factors behind shortage, productivity and mobility of health personnel in Sub-Saharan Africa.

Bruce-Brand et al. (2012) put the accent on the Irish Health system, where the number of applications for non consultant hospital doctors is decreasing. The main reason for seeking foreign opportunities are better training and career opportunities abroad.

Kronfol, N.M. (2012) reviews the essential components of health care delivery systems in Arab countries and their development over the past 3 decades. The changes and challenges that evolved during the last half of the 20th century have had a significant impact on health systems and on health outcomes. An adequate network of hospitals and primary health care facilities has been established in most Arab countries of the Region. The increased participation of civil society has impacted positively on health systems. However, the main challenge is represented by the move towards market economies. In many developing economies, macroeconomic reforms have often necessitated cuts in public spending on social sectors. Cost-sharing policies have been implemented in order to compensate for diminishing government budgets allocated to health. However, this is not to minimize the enormous strides that have been made in all countries nor the important challenges that need to be addressed.

El Mahdi et al. (2013) assess the current status of the education and social protection systems in 11 southern and eastern Mediterranean countries. The study compares these countries using various education indicators and attempts to highlight the main differences in the social protection systems among the countries, using qualitative analysis. The report finds that despite the differences among the countries, they share a common feature: when measured by the UN Development Program's Human Development Index (HDI), their inequality-adjusted values are significantly lower than their HDI values and ranks when not taking inequality into account. Nevertheless, significant improvements have been achieved in all the quantitative indicators for education, while the qualitative performance is still modest in the majority of the countries studied. As to the social protection aspect, the research reveals that various social protection programs are being adopted in the 11 countries. As most of their financing is covered by government budgets, however, this places a high fiscal burden on them. Yet few of the countries (Turkey being the most notable) are trying to improve the sustainability of their social insurance schemes.

Murray et al. (2012) refer to the complexity in the relationship between globalization and health as they are many methodological approaches. The findings show that bio-medical and population health perspectives have been dominant but that social science perspectives have become more evident in recent years. The types of paper published have also changed with more emphasis placed on the contributions from social sciences.

Vujicic et al. (2012) Shortages, geographic imbalances and poor performance of health workers pose major challenges for improving health service delivery in developing countries. In response, multilateral agencies have increasingly recognized the need to invest in human resources for health (HRH) to assist countries in achieving their health system goals. In this paper we analyze the HRH-related activities of three agencies: the Global Alliance for Vaccines and Immunization (GAVI); the Global Fund for Aids, Tuberculosis, and Malaria (the Global Fund); and the World Bank. First, we reviewed the type of HRH-related activities that are eligible for financing within each agency. Second, we reviewed the HRH-related activities that each agency is actually financing. Third, we reviewed the literature to understand the impact that GAVI, Global Fund and World Bank investments in HRH have had on the health workforce in developing countries. Our analysis found that by far the most common activity supported across all agencies is short-term, in-service training. There is relatively little investment in expanding pre-service training capacity, despite large health worker shortages in developing countries. We also found that the majority of GAVI and the Global Fund grants finance health worker remuneration, largely through supplemental allowances, with little information available on how payment rates are determined, how the potential negative consequences are mitigated, and how payments are to be sustained at the end of the grant period. Based on the analysis, we argue there is an opportunity for improved co-ordination between the three agencies at the country level in supporting HRH-related activities. Existing initiatives, such as the International Health Partnership and the Health Systems Funding Platform, could present viable and timely vehicles for the three agencies to implement this improved co-ordination.

McCarthy (2012) discusses about public health research and systems in the EU that can help in the efficiency and effectiveness of health care, as well ways for contribution to population health and social wellbeing. The health care research vary subsequently from Scandinavian countries and UK with high level of research and low in the south eastern European countries, EU's Science in Society program has developed and making funds for STEPS (Strengthening Public Health Research in Europe) in order to evaluate the public health research in EU, basically new countries. Policies should be set up to encourage EU's Structural Funds to promote public health research.

II. Factors Affecting Health Workforce in Developing Economies

There are many factors and trends that are affecting the shortages in medical doctors in developing economies. Emigration is the consequence of these factors that place pressure on domestic health systems.

1. World Distribution of Benefits

At all level of the health system, developed economies have appeared to be occupying dominant positions in production, use and trade of health care outputs issued from new technologies. As shown in Driouchi and Kadiri (2010), developed countries are also those that have control over different advanced technologies. But, the health benefits of these advances are clearly distributed worldwide and attain most world population.

While developed countries have been ensuring means and instruments to provide full health coverage, this process is still limited in the developing world. Efforts involving different national and international organizations appear to be promoting new means to enhance the level of health benefits in these economies. The millennium development goals framework is a global framework devoted to series of actions to ensure the attainment of some realistic objectives by 2015. While this overall trend has been developing, some emergent economies have been accelerating the process of production and use of the innovations from the new health system.

2. Health Workforce Density per country

The number of health workforce specialists per country in relation to the population of the country as represented by the density per 1000 people can be used as indicator of the availability per country. But, this is an overall average as different country, regional and global reports by World Health Organization discuss the spatial disparities in distribution of medical personnel.

Regression analysis is conducted to show how different densities of different types of specialists are related. This exercise is conducted respectively for all countries, for the set integrating Arab and Central Eastern European economies (ECE), then for Arab and ECE countries.

2.1. All Countries

The following table 1 shows the best regressions obtained. Nursing and midwifery besides pharmaceutical personnel appear to have statistically significant effects with respective coefficients of 0.027 and 0.251. The related degrees of freedom are 102 with

and R^2 of 0.660. This implies that each unit of nursing adds 0.027 physicians while a one unit of pharmacist adds 0.251 physicians. The second regression (table 2) with only 62 degrees of freedom and R^2 of 0.611, shows that "laboratory health workers" exhibits also an effect that is statistically significant (0.480).

Table 1: Overall Regression

Dependent Variables	Independents Variables	Values	t-Stat	R^2	Degrees of Freedom
Physicians density (per 1000 population)	(Constant)	.133	2.528	.660	102
	Nursing and midwifery personnel density (per 1000 population)	.027	9.018		
	Pharmaceutical personnel density (per 1000 population)	.251	4.931		
Physicians density (per 1000 population)	(Constant)	.139	1.170	.611	62
	Pharmaceutical personnel density (per 1000 population)	.449	2.012		
	Laboratory health workers density (per 1000 population)	.480	4.890		

2.2. Arab and ECE countries

But, the above global results are changed when looking at the results from the best regressions obtained from the sample of Arab countries and Eastern and Central European economies. The two respective regressions have R^2 of 0.765 and 0.301 with 26 and 28 degrees of freedom. Nursing and dentistry have estimated coefficients of 0.044 and 0.434 in the first regression. The second regression shows pharmaceuticals and laboratory workers respectively with coefficients of 0.354 and 0.358.

Table 2: Regressions for Arab and ECE countries

Dependent Variables	Independents Variables	Values	t-Stat	R^2	Degrees of Freedom
Physicians density (per 1000 population)	(Constant)	.223	1.344	.765	26
	Nursing and midwifery personnel density (per 1000 population)	.044	4.337		
	Dentistry personnel density (per 1000 population)	.434	3.803		
Physicians density (per 1000 population)	(Constant)	.235	5.784	.301	28
	Pharmaceutical personnel density (per 1000 population)	.354	3.411		
	Laboratory health workers density (per 1000 population)	.358	3.892		

2.3. Arab Countries

With limited degrees of freedom, the density of physicians is statistically and significantly related to the nursing and midwifery density. It is also related to the density of pharmacists but the other regressions show that the density of dentist has also a statistically significant explanatory power. The same thing applies to explanatory variables such as laboratory health workers, environmental and public health workers besides other health workers.

Table 3: Regression for Arab countries

Dependent Variables	Independents Variables	Values	t-Stat	R^2	Degrees of Freedom
Physicians density (per 1000	(Constant)	.166	.624	.979	3
	Nursing and midwifery	.096	5.883		

population)	personnel density (per 1000 population)				
	Health management & support workers density (per 1000 population)	.090	-2.265		
Physicians density (per 1000 population)	(Constant)	.166	4.493	.746	17
	Pharmaceutical personnel density (per 1000 population)	.222	6.848		
Physicians density (per 1000 population)	(Constant)	.207	3.022	.678	17
	Dentistry personnel density (per 1000 population)	.412	5.800		
Physicians density (per 1000 population)	(Constant)	.252	.520	.930	4
	Laboratory health workers density (per 1000 population)	.445	6.304		
Physicians density (per 1000 population)	(Constant)	1.208	-4.046	.961	2
	Environmental and public health workers density (per 1000 population)	17.556	4.975		
	Other health workers density (per 1000 population)	.247	.334		
	Laboratory health workers density (per 1000 population)	.247	1.786		

2.4. ECE countries

With also limited degrees of freedom, the density of physicians appears to be related mainly to health personnel in dentistry and to nursing.

Table 4: Regressions for ECE countries

Dependent Variables	Independents Variables	Values	t-Stat	R^2	Degrees of Freedom
Physicians density (per 1000 population)	(Constant)	.385	3.806	.506	13
	Dentistry personnel density (per 1000 population)	.721	3.506		
Physicians density (per 1000 population)	(Constant)	.753	1.363	.298	13
	Nursing and midwifery personnel density (per 1000 population)	.119	2.255		

The above results show how different densities related to different components of health workforce are inter-related. But, the variable related to physicians has more accurate role in determining the distribution of other components of health personnel.

III. Constraints to Health & Impacts on the Health Workforce in Developing Economies

This starts with showing the effect of high technologies on health in developed and developing economies. The constraints related to new technologies in developing countries constitute the second component of this paragraph.

1. Medical Human Resources

Human capital is at the center of health care system (WHO, 2006). The number and quality of workers are positively associated with immunization coverage, outreach of primary care and infant, child and maternal survival. Naicker and Tutt (2009) emphasized the state of medical human resources in Africa and the world. According to this study, 1.3% of the global health care workforce is devoted to 25% of the disease burden

representing a shortage of 817,992 health workers in Africa. In 2008, Africa had 2.3 health workers (physicians and nurses) for 1,000 individuals when Europe and Americas had 18.9 and 24.3 respectively. When taking the number of physicians per 100,000 people (HDR, 2007), while the highest number of physicians varies from 318 to 591, it is between 2 and 12 physicians per 100,000 people for the lowest number category. Besides, the limited number of medical schools put additional pressure on the available stock of physicians in the home country (FAIMER, 2010; WHO, 2010).

	Diseases (number of reported cases)				
Countries	Measles	Pertussis	Total Tetanus	Tuberculosis	Rubella
Australia	65	14,435	4	299	38
Belgium	98	260	2	311	5
Canada	41	1,961	1	488	
France	604		8	1,222	
Germany	917			954	
Japan	11,015	6,753	123	8,995	303
Spain	297	563	15	2,333	70
Switzerland	2,022		1	64	12
United Kingdom	1,445	1,028	5	1,028	31
United States	140	13,213	0	13,213	16
% of the global	6%	25.5%	1%	1.4%	0.3%

Table 5: Examples of Emerging Diseases in Developed Countries (2008)

These deficits are due to the domestic increases in demand for and emigration of health human resources. Danon-Hersch and Paccaud (2005) considered that since human resources are affected by progress in technology, health care systems should improve

education and training for medical human resources and for administrative and management. The increase in demand is also due to the expansion of medical coverage, the extension of hospitals and the shift from traditional medicine and aid systems to modern health systems (Ron, 2008). A study by Driouchi et al., (2009) shows the higher levels of interdependencies between health and education. While there are major needs for medical doctors and nurses, preferences for urban centers (Driouchi, 2008) as well as emigration to other countries are affecting the coverage rate which can be critical in some regions. Emigration of nurses and medical doctors is taking place under the effects of salary differential and living conditions (Driouchi & Kadiri, 2010).

Country of training	Number of African-trained IMGs in USA	Number of African-trained IMGs in Canada	Number of physicians remaining in home country	% of total African-trained now in USA or Canada
Nigeria	2158	123	22 894	9
South Africa	1943	1845	23 844	14
Ghana	478	37	1210	30
Ethiopia	257	9	1564	15
Uganda	133	42	722	20
Kenya	93	19	4001	3
Zimbabwe	75	26	1694	6
Zambia	67	7	676	10
Liberia	47	8	72	43
Other 12 countries	83	35	12 912	1
Total/Average	5334	2151	69 589	10

Table 6: Country of medical school of sub-Saharan African international medical graduates (IMGs) in the United States and Canada

Yusuf et al. (2010) looked at different implications of the brain drain in the area of medical human resources. The shortage of medical doctors in developing economies is also accelerated by the massive engagement of students at earlier ages in foreign medical education systems, thus, reducing the probability of return of graduates. This shortage is likely to accelerate with ageing, retirement and pressures of population needs (Dodani & LaPorte, 2005). Table 6 shows the extent of medical doctors' emigration from sub-Saharan African countries to the US and Canada (10%).

2. Evidence about the relationship between advanced technologies and knowledge

It is widely known that developed countries are benefiting more from advanced technologies, relative to developing economies. One simple way to test for this evidence is to see how health is responsive to technologies at the overall and in each group of countries. Using technology indices such as the Global Innovation Index (GII) (INSEAD, 2010), the Knowledge Economy Index (KEI) (World Bank Institute, 2010) and the measure of Technology Exports (TE) (World Bank Data, 2010). Only the first two indicators appear to exhibit statistically significant relationships with the life expectancy at birth, taken as a proxy for health performance (Table 7). Estimations difficulties related to this regression have been tackled through using literacy rate per country as instrument for life expectancy at birth.

	GII			KEI		
	All Countries	Developed	Developing	All Countries	Developed	Developing
Coefficient	0.42	0.18	0.48	0.25	0.18	0.24
STD Error	0.05	0.02	0.17	0.02	0.01	0.04

t-Stat	8.04	7.50	2.40	15.00	6.23	6.80
R^2	0.43	0.47	0.10	0.62	0.36	0.45
Observations	130	66	64	141	71	70

Table 7: Responsiveness of health to technologies

The results shown in the above Table 7 clearly indicate that life expectancy at birth is influenced by technologies. The coefficients of sensitivity are respectively 0.42 and 0.25 for GII and KEI for all countries. For developed economies, the coefficient is 0.18 for both GII and KEI. But, given the estimated standard error for each coefficient, the levels of responses appear to not be different between countries. This implies that developed, developing and all countries exhibit the same coefficient as it is confirmed in Table 8 with the calculated t-statistics. Therefore, only higher levels of the technology index (GII and KEI) determine higher life expectancy at birth in developed economies. With lower levels of technologies, lower life expectancies at birth are observed at the level of developing economies.

Comparisons/t-stat	GII	KEI
all/developed	0.000733107	1.39925E-05
all/developing	0.000161037	5.33488E-06
Developed/developing	0.000802044	3.19934E-05

Table 8: Comparisons of coefficients

These results are confirmed when using healthy life expectancy at birth, overall mortality, mother and children mortality rates as respective measures of health performance. The results confirm that developing countries with limited access to high levels of technologies achieve lower levels of health performance. The following paragraph addresses market and non market constraints that might be behind the lower access to

advanced technologies and the lower performance in health with major impacts on human resources.

Discussion

The pressure of tasks form health care, introduction of new technologies and participation to medical research is enlarged with the constraints described above. These limits create shortages in relation to the increasing and large demand. One of the means to address the above cited shortcomings is to move toward World Health Systems and global linkages, with connections to local areas and countries. This is within a cooperative framework that has been already increasing between developed and developing countries (Gostin et al., 2010). International medical cooperation and access to the outcomes of advanced technologies will help reduce technology and research gaps between developed and developing countries. Neglected diseases should receive enough care from research labs especially that Reidpath et al., (2011) found that neglected tropical diseases (NTD) research is a biomedical area more than social science- related. Pokhrel et al., (2011) concluded that more social science based NTD research is needed and funding for it is not as low as it seems.

Technological advancement and research should not be carried without considering the training of human factor implying that medical education is also linked to overall process of improving the health system. Therefore, national education systems should train more medical personnel to satisfy the increasing demand. It should also include integrated medical training and research. To enhance health knowledge and practice globally, Ruger

and Ng (2010) describe the roles that emerging countries play in supplying global health and redressing health inequities.

Conclusion

The objective assigned to this paper is attained with the overview on the new and increasing requirements for human resources in the health care. Further quantities of human resources are need and more skills are required. The increasing complexity of the health care process and its environment with the increasing introduction and development put further pressure on the system with its human resource components. The potential and new skills are to be introduced and pushed at both levels of medical regular training but also in the professional and training opportunities.

The limitations affecting health care even, under higher development of new advanced worldwide technologies are likely to occur in the absence of the skills and size of the health workforce.

These dimensions are developed in the present paper trough looking first, at the trends characterizing the world development of the new health system and its evolution under the impulse of new technologies. This is followed by an overall analysis of the major constraints facing developing economies. The relationships with the health workforce are addressed in the two sections.

Within this context, the features related to the world development of new health technologies and practices under the effects of new technologies are reviewed. They consist in increases in the flows of outputs related to new technologies with their applications in health care, globally. But, these promising trends have generated

important shifts where private interests have been increasingly involved in the new health care systems with expanded costs and higher financial requirements to every partner in the chain of the health system, including patients. The implied financial burden is shown to be leading to higher financial requirements and mainly to the expansion of social health care systems where private insurances are progressively developing. This leads to an increasing number of players concerned with the new health systems. While this is true for both developed and developing countries, some economies in the developing world are finding their way out to ensure better health care systems in the emerging developing economies. But, other countries have more limitations in accessing and benefiting from the global system.

These countries appear to be faced with problems related to the fragmentation and the scattered components of the health system that lead to blocking the access to different segments of the health care. This is intensified with the limitations in medical research. Furthermore, the staffing requirements under both the pressure of increasing demand for medical care and the emigration of health personnel are major additions to the constraints facing the expansion of the benefits from new advanced technologies in health care in the developing economies. While patenting can be used to preserve the interests of innovators, they can be sources of additional costs and time. Solutions to the above problems may reside in ensuring that developing countries be further engaged in a global health system where different players and partners are converging to ensure that all are accessing to the best health care processes under the full access to new technologies. In this process, the role of medical doctors in both research and medical care is important. An overall mobility could be beneficial to both receiving and sending countries.

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