

Frontiers of Improvement

Frontiers in human factors: integrating human factors and ergonomics to improve safety and quality in Latin American healthcare systems

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Abstract

Background: The importance of human factors/ergonomics (HFE) is well established in all high-reliability systems but only applied in the healthcare sector relatively recently. Across many sectors, low-/middle-income countries (LMICs) lag behind more economically developed countries in their application of this safety science, due to resource and, in some cases, awareness and expertise. Most previous applications of HFE related to occupational ergonomics rather than healthcare safety.

Methods: The paper details how the reputation of HFE is being developed within healthcare communities of Latin America (LatAm), through increasing awareness and understanding of its role as safety science in the healthcare sector. It starts by articulating the need for HFE and then provides examples from Mexico, Colombia and Peru.

Results: The practical examples for research and education illustrate a developing awareness of the relevance of HFE to the healthcare sectors in LatAm and an appreciation of its worth to improve health service quality and patient safety through healthcare community engagement. A new LatAm Network of HFE in Healthcare Systems (RELAESA) was formed in 2019, which has provided a platform for HFE advice during the COVID-19 pandemic.

Conclusion: There is a real opportunity in LatAm and other LMIC health services to make more rapid and sustainable progress in healthcare-embedded HFE than has been experienced within healthcare services of more developed nations.

Key words: human factors, healthcare, LMICs, improvement, patient safety, systems ergonomics

Introduction

Human factors/ergonomics (HFE) contributions to knowledge and improvement in the healthcare sector have largely occurred in more economically developed countries. It has been suggested that the demand for HFE in low-/middle-income countries (LMICs) far exceeds the supply, and much more can be offered in LMICs, where needs and inequalities are greater than in other areas of the world [1].

In Latin America (LatAm), HFE has been applied with occupational ergonomics projects in the primary and secondary economy sectors, with fewer applications in the tertiary service sector (including healthcare) [2–4]. There is little evidence of awareness of HFE in healthcare, and as a result there is little demand despite increasing calls for its inclusion in patient safety and quality of health service delivery [5].

The disparities in healthcare resource between LMICs and more economically developed nations are stark (Table 1). The staffing statistics raise questions about individual, team and organizational workload; burnout and work-related injury and absenteeism [6–8]. The Organisation for Economic Co-operation and Development (OECD) highlights poor care quality and inequality of provision in Mexico [9], Colombia [10] and Peru [11]. The healthcare sectors within each of these countries operate via a combination of social insurance systems, private insurance systems and government schemes for low income and socially deprived [12, 13].

- Colombia has a healthcare system formed by three subsystems: health, pension and labour risks. The contribution to the health subsystem is 12.5% of the worker's gross salary (4% is contributed by the worker and 8.5% by the employer). The contribution to the pension subsystem is 16% (4% by the worker and 12% by the employer). In the labour risks subsystem, contributions are made in full by the employer and vary between 0.522 and 6.96% of the gross wage, depending on the risk classification of the job. Medical care is provided through either public and/or private care; healthcare is decentralized and implemented at district, department and municipality levels. The Latinobarometer [13] reported that 61% citizens were happy with their level of healthcare.
- Mexico has a social insurance system funded by wage contributions, employers and government, which covers private-sector employees (IMSS in Spanish). Additionally, there are private services and a social assistance programme (called Seguro Popular, changed recently to INSABI) funded by the government for the poor. Medical care is available through many separate systems depending on insurance membership or public hospitals; access to care varies widely according to individual circumstances. The Latinobarometer [13] reported that 57% citizens were happy with their level of healthcare.
- Peru has a social insurance system (ESSALUD) and private insurance plans (EPS), which are funded by self-employed, pensioners and employers. The integrated health insurance system (SIS) provides free care for the extremely poor. The systems are funded by self-employed, pensioners and employers; care can be provided through EPS or ESSALUD. The Latinobarometer [13] reported that 26% citizens were happy with their level of healthcare.

The WHO commissioned the first LatAm based patient safety report (IBEAS), the detail of which included a specific study of Adverse

Events [14]. This investigation reports up to 20% of patients experience at least one harmful incident during their hospitalization, and suggests that 28% of Adverse Events caused disability to patients, with 6% associated with death [14]. It also proposed that more than half of harmful incidents were avoidable.

These inequalities serve as a driver [1], for HFE integration into health and social care services in LatAm, for the promotion of better safety and performance in these complex socio-technical systems [14]

In this paper, we provide examples of healthcare-based HFE activity in Mexico, Peru and Colombia using the 'HFE demand development cycle' [16]:

- Stakeholder's demand for high-quality HFE, which can stimulate
- the application of high-quality HFE (with the three key characteristics), which can
- raise the stakeholder's awareness of the need for high-quality HFE, which may
- increase the stakeholder's demand for high-quality HFE.

In this cyclical representation of developing demand through awareness and application, there is no clear starting point for HFE sustainable demand. Our examples for research, education and healthcare communities engagement do not seek to comment on the directionality of impact but propose that simultaneous momentum, where possible, will ensure growth in demand.

We discuss how HFE needs, awareness and applications are significantly different between LMICs and more economically developed countries (Figure 1). Over time, we would like to see the healthcare systems in Colombia, Mexico and Peru move towards a situation of embedded HFE expertise.

HFE in research

Research can stimulate increasing demand for HFE, and the examples of healthcare HFE from Mexico, Peru and Colombia all have this as a core factor for developing a sustainable HFE strategy.

The initial impetus for collaboration came from an (unsuccessful) grant application that resulted in extensive networking and opportunities.

The first example is 'Investigating novel methods and best practices for service design and patient safety in the Mexican healthcare service'. This research project is a collaboration between the University of Nottingham, the Ergonomics Research Centre (ERC) at the Universidad de Guadalajara (UdG) and the Hospital Civil de Guadalajara (HCG). The research enabled the team to gain the confidence of, and buy-in from, senior management and planning and development teams in two hospital sites, which was vital for the success and ongoing commitment to the project. This research triangulated the data about staff needs and patient safety challenges through multiple elicitation activities and highlighted the importance of top-down and bottom-up data gathering from different hospital staff groups [17].

The second example is from Colombia, where research priorities in healthcare settings were explored with a questionnaire to 62 workers in 51 public hospitals in the region of Antioquia, Colombia. The highest priority research findings were occupational safety and health culture, analysis of human error, analysis of incidents, risk assessment related to work-related musculoskeletal disorder (WRMD), patient safety, quality in health services and human resource management [18].

Third, in Peru, there was a recognized statement of need for safer working in surgical environments and to investigate WRMD risks

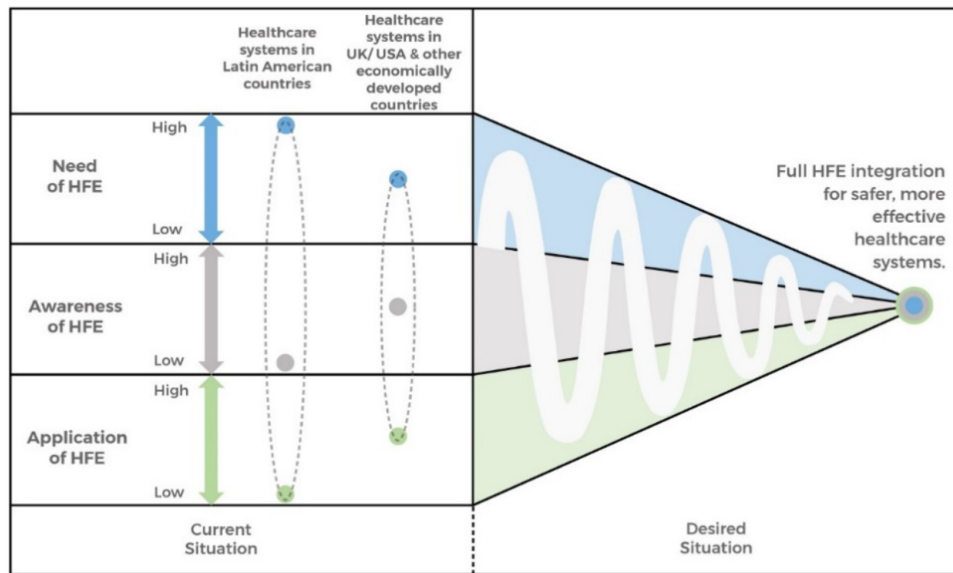


Figure 1 HFE-desired integration in healthcare systems.

Table 1 Healthcare indicators by country [20]

Country (population)	Hospital beds (per 10 000) (2013–2015)	Total expenditure on health; % of gross domestic product (2014)	Medical doctors (per 10 000) (2016–2018)	Nursing and mid-wifery personnel (per 10 000) (2017–2018)	General government expenditure on health, % of total government expenditure (2014)
Brazil (207.6 million)	22	8.32	21.64	101.2	6.78
Colombia (48.6 million)	15	7.2	21.85	13.31	18.14
Germany (81.9 million)	82.78	11.3	42.49	132.4	19.65
Italy (59.4 million)	34.22	9.25	39.77	57.4	13.65
Mexico (127.5 million)	15.2	6.3	23.83	23.96	11.58
Peru (31.7 million)	16	5.47	13.05	24.4	15
Spain (46.3 million)	29.65	9.03	38.72	57.3	14.5
United Kingdom of Great Britain and Northern Ireland (65.7 million)	27.58	9.12	28.12	81.72	16.52
USA (322.1 million)	29	17.14	26.12	145.5	21.29

in laparoscopic surgeons [19]. The Peruvian government is supporting research to investigate the daily practice of surgeons in Peru by establishing HFE standards in the design of technology for surgical training; applying HFE to equipment design; and introducing HFE to the work system and medical procedures for improved patient safety.

The HFE research in the three countries differs in the approach, depending on funding, timeline and opportunity. However, each has and continues to demonstrate the professionalism of HFE as a scientific discipline with relevance and benefits to healthcare.

Education of HFE specialists

Within LatAm the strategy is to grow HFE education, ensuring that learning and HFE practice are relevant to local context and challenges. This approach will also add value by making clear the links between HFE education and research opportunities, directly leading to increases in demand and capacity for HFE application to the LatAm healthcare sector.

In Mexico, HFE specialist education is delivered as an MSc at the ERC (UdG) [21], the only course in the country dedicated entirely to

this discipline. It is recognized by the National Research Council as a high-quality course and aligns with the International Ergonomics Association (IEA) competency framework. Since the initiation of the ERC healthcare research agenda, increasing numbers of MSc project studies are undertaken in healthcare, to maintain and build new relationships within healthcare organizations. These projects include medical technology evaluations [22], design of clinical waiting rooms for patient experience [23] and investigating information characteristics on healthcare service provision [24].

Colombia's HFE education strategy was directly informed by the HFE healthcare research priorities elicitation research study [18] with two significant actions at the National School of Public Health of the Universidad de Antioquia. The first is the inclusion of healthcare-specific HFE examples in the postgraduate course in ergonomics to equip future graduates with an understanding of this domain and application. The second is the development of a healthcare HFE research agenda within the postgraduate programmes in ergonomics and occupational safety and health.

Similar growth is seen in Peru with MSc programmes offered by two private universities with a particular emphasis on HFE in the workplace. The Universidad Científica del Sur delivers one of the HFE programmes with support from the Peruvian Society of Ergonomics; this alliance supports the development and delivery of a high quality curriculum (based on the IEA competency framework) to train future HFE practitioners in Peru.

Engaging healthcare communities with the HFE profession

There are multiple ways of engaging healthcare communities, all of which have a purpose in communicating and building partnerships. Some take a top-down approach, while others use contacts and specific statements of need to establish working relationships and collaborations from the bottom-up. Both strategies enable engagement at different levels within an organization.

Mexico has successfully communicated the value of applied HFE to strategic stakeholders at the HCG, specifically Quality Management and the International Liaison Departments. Much of this progress is due an early local HFE advocate (BGM) who worked with HFE experts (CAG, ARL) and proactively engaged senior gatekeepers and stakeholder groups to enable the collaborative training programme. Invited talks (SH, ARL, CAG) and networking at the annual hospital congress (CIAM) enabled ongoing dialogue with the healthcare community. Subsequent presentations led to the managers of the HCG being supportive of HFE led projects and an ongoing partnership underpinned by memorandums of understanding (MoU) to provide a framework for collaborative working, including research projects, teaching activities and public engagements. The MoUs with HCG are particularly significant due to its regional reputation as the biggest hospital in LatAm to serve people without social security.

The delivery of workshops introduced HFE to staff at the HCG built on an introductory programme from the UK [25]; it elicited data on safety priorities of hospital staff to feed into the research agenda [26]. The workshop was delivered at the International Conference of Advances in Medicine (CIAM 2019, 2020) followed by an initiative at HCG to develop a team of 'Ergonomics Ambassadors' where workshop participants are given additional education in an additional HFE method (hierarchical task analysis).

At the request of the HFE team, HCG has enabled hospital staff from different backgrounds to attend these courses, e.g. clinical

and nursing staff, laundry and portering leads, allied health personnel such as nutritionists and psychologists. This is now an ongoing scheme between UdG and HCG to sustain and grow the Ergonomics Ambassadors scheme.

The Colombian approach to engagement has involved the presentation of HFE as a scientific discipline to healthcare professionals at medical and pharmacological conferences, for example, the invitation of HFE experts (CAG and YR) to present 'the importance of HFE in pharmacovigilance' at ISO 2019, Colombia [27]. These activities are raising awareness of systems thinking, the role of HFE in the health sector and its importance in reducing medication errors.

Progress in HFE learning for healthcare stakeholders outside higher education institutions is exemplified by a forum on medication errors [28] with 141 participants from 37 institutions including universities, pharmaceutical industry, hospital and healthcare associations, the Ministry of Health and trade unions.

The approach in Peru has similarities with Mexico with direct involvement of healthcare practitioners. For example, a project is ongoing with 140 laparoscopic surgeons in HFE, including training for 60 doctors. This has engaged with heads of surgical departments, university medical faculties (such as Experimental Surgery Institute of University of San Marcos) and the Peruvian Endoscopic Society, to communicate the benefits of the HFE approach. The demand is growing with invitations to deliver general HFE training at regional surgery congress (MEG), and at the Centro de Estudios para la Prevencion y Correccion de Enfermedades Abdominales, an endoscopic training centre.

LatAm Network of HFE in Healthcare Systems

As in other sectors and countries, the demand for HFE in healthcare has come from negative incidents involving death or injury, for example, high profile case of medication error [29], where the Colombian Association of Pharmacovigilance sought advice from HFE experts (CAG and YR) to understand the event from a systems perspective. In the short term, the growing demand for HFE in LatAm health systems is coming from existing partnerships between healthcare service providers and HFE academics (CAG, YRR and MEG).

A recent development is the creation of the LatAm Network of HFE in Healthcare Systems (RELAESA), instigated by CAG in 2019 as the focal point for developing HFE demand in healthcare within and between LatAm countries. Its role is to match needs from healthcare communities with HFE expertise, while continuing to generate awareness, thus perpetuating the cycle as described by Dul *et al.* [16]. Demand for HFE is expected to increase faster due to RELAESA investing in relationships with other associations of health and HFE professionals. Membership is increasing with HFE experts and individuals with knowledge and skills in HFE subspecialties, e.g. physical ergonomics/factors (such as occupational ergonomics) and healthcare staff and professionals. To date, there are representatives from Argentina, Colombia, Chile, Brazil, Ecuador, Mexico and Peru following the activity of the network. Long-term demand will come from introducing HFE in healthcare professional training early in their career (clinical and non-clinical) to understand systems thinking and how design can improve safety and performance. This will develop a workforce which is empowered to integrate HFE into healthcare work systems, as they become drivers of change and decision makers within the system.

Dul *et al.* [16] describe the (mis) match between potential value, perceived value and provided value of HFE in systems

There is a real opportunity in LatAm and other LMIC, health services to capitalize on the fact that there are currently no misrepresentations of HFE to add confusion around its value proposition in healthcare. HFE is a safety science [30], which uses evidenced based systems thinking and design approaches to improve the quality and experience of healthcare services. It is possible that by starting from a more naive position, LatAm healthcare communities, in partnership with local HFE experts can make more rapid and sustainable progress in healthcare-embedded HFE than has been experienced within healthcare services of more developed nations.

COVID-19: an immediate challenge

The current COVID-19 pandemic is putting unprecedented pressure on healthcare systems around the world. Table 1 illustrates how poorly resourced some LatAm jurisdictions are which provides a stark message about the ability of these systems to cope with the extraordinary burden that a pandemic brings. These statistics are latent contributors to negative effects on staff, service quality and patient safety and demonstrate how some/many LMIC healthcare systems are not adequately designed to support human performance in 'normal' times, let alone imminent threats associated with the current crisis.

Some RELAESA members have been actively providing HFE guidance where possible to reduce the negative consequences of COVID-19. The main actions include making information from international HFE organizations such as the CIEHF, HFES and IEA accessible to health institutions and government bodies. Some resources, such as the commentary of Gurses *et al.* [31], have been translated to increase accessibility in LatAm to promote and facilitate partnerships and applied work during these challenging times.

Conclusion

This 'future place' of embedded HFE will see better patient safety, quality and performance of service and improved experience for service users and providers to have a positive impact on their confidence in their own 'duty of care'. By integrating HFE into the system, they can have full confidence in this principle, that their system of work is better designed to provide safer and more effective healthcare service than without it.

This paper aimed to communicate the need for proactive, early HFE integration in LatAm healthcare to avoid patient safety incidents and produce safer and more effective work systems. There is a small pool of experts who are disseminating their knowledge for wider uptake of HFE within LatAm and to other LMICs. While there is much further work to be done, there can be no doubt of the potential benefit that HFE growth will contribute to these resource-scarce and overburdened healthcare services. Our ambition is that integrating HFE principles and practices will help to transform all aspects of our healthcare systems in LatAm.

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Data availability

No new data were generated or analysed in support of this review.

Conflict of interest

The authors declare no potential conflicts of interest.

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