

Design of Virtual Infrastructures for Public and Private Services: The Indian Health Care System

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Abstract

The objective of this paper is to identify the emergent virtual health care infrastructures of the Indian health care system. Particular attention is focused on the role of these infrastructures serving diverse public and private system stakeholders in service delivery, education, research and governance. This qualitative study describes how virtual infrastructures integrate the increasingly decentralized health care system- including national and individual citizen levels of analysis. Decentralization of services helps to assure system integrity and effectiveness through local data collection, accountability and evidence-based management, while public-private partnerships contribute to system efficiencies. This paper defines some managerial issues in the perspectives of diverse stakeholders including government institutions, non-governmental organizations (NGOs), public and private health care providers, patients, and other consumers.

1. Introduction

As the world's largest democracy, India faces the vast challenge of developing a national health care delivery system to offer equitable and effective services to a culturally and economically diverse population of more than one billion citizens. Since the early 1990s, international development organizations including the World Bank and the World Health Organization have promoted decentralization of government institutions in developing countries as well as privatization of public services including health care. Health care services in India are delivered through a widely diverse institutional system integrating a donor-supported social medicine model as well as a large number of private organizations, both for-profit and not-for-profit, under Indian as well as foreign ownership and control. This ideological diversity poses a formidable challenge

to policy makers engaged in the restructuring of the Indian health care system.

Organization cultures, political ideologies and business models contribute to the challenge of diversity in health care systems at the local, regional, national, and global levels of analysis. The boundaries of a national health care system remain unclear, particularly where the system is undergoing a high rate of change under increasingly global market forces. Boundaries of competence best describe the health care system as a function of the resources and linkages required for service delivery. [1] In the social medicine model necessary resources are primarily defined by the provider, while in the consumer driven model, the consumer determines these resources. Thus markets and hierarchies represent mechanisms for coordination in economic and health care systems. Virtual infrastructures transform the dynamics of both markets and hierarchies and introduce new configurations of structure and process. These infrastructures increase communication while decreasing associated costs through electronic brokerage and integration effects. Electronic brokerage can increase the number of choices considered by consumers and providers as well as the quality of products or services selected, while at the same time lowering the cost of the choice process. The electronic integration effect decreases the time required and other costs of linking information creation and use. [2]

The Indian system encompasses diverse actors in both social medicine and consumer driven models including public and private providers in traditional and modern medicine. The integration of these diverse actors in effective health care service delivery may affect the performance of the system. [3] Research has shown that mechanisms for distribution of wealth and investment in public health mediate the association between GNP and population health indicators such as life expectancy and infant mortality. [4] For example, ideologies are expressed

through regimes of property rights affecting the very linkage between human beings and social systems. Not only is this linkage fostered through centralized systems of governance and regulation, but it is also sustained through traditional or indigenous knowledge at the local level. A further challenge to design of health care systems is the nature of services delivered and the definition of health as a product or outcome. It is the central thesis of this paper that public health may be viewed as a social ecosystem maintained through ideologically diverse health care institutions integrating public, private, and common property regimes. [5]

The Indian health care system offers an opportunity to consider this perspective with a particular focus on the usefulness of virtual infrastructures to integrate, public, private, and community actors at institutional and individual citizen levels of analysis. Virtual infrastructures refer to an environment characterized by overlapping distribution networks, systems brokerage functions, and the adoption of a software perspective emphasizing the devices and channels through which information is processed and distributed. A distinguishing feature of these infrastructures is a layer of abstraction between the computing, storage and networking hardware, and the software technologies that allow multiple operating systems to run on the same processor. This layer of abstraction leads to standardization and the support of legacy operating systems and applications on current hardware and software platforms. Virtual infrastructures in turn are accessible through Internet websites and gateways designed to facilitate integrated use of available resources. The adjective “virtual” thus describes any web-based product, service, organization or institution arising from the technical infrastructure defined above.¹ [6] This definition is consistent with the concept of cyberinfrastructure describing new research environments that support advanced data acquisition, storage, management, integration, and other computing and information processing services over the Internet. [7]

Health care services networks accessible on the Internet may be viewed as a virtual commons contributing to innovation and service delivery. [8] Their role can be particularly critical to integrate public and private sector activities essential to health care innovation in developing countries including: creation of information and databases, fundamental and applied research in health related disciplines, education in medicine and public health, and service delivery.

While data on country-level innovation is limited, some research suggests that developing countries'

publication intensity, defined as the number of scientific publications (generally the Social Sciences Citation Index - SSCI) per capita, is higher than global averages in areas of medical research that address their own health needs. Products available on international markets illustrate such innovation capacity, especially in vaccine research. For example, the first effective meningitis B vaccine developed by the Finlay Institute in Havana has been licensed for production and distribution to GlaxoSmithKline, and the anti-malarial drug arteether now distributed in 48 countries was developed at the Central Drug Research Institute of India and commercialized by Themis Chemicals. [9] These examples show the critical partnership between public and private sector organizations in the developing countries where most health research is supported by public sector infrastructures. [10] Innovation in health research and service delivery in the developing countries is founded upon such national infrastructures as well as networks of collaboration and practice extending beyond national boundaries.

Research suggests that implementation of ICTs and Internet infrastructures may contribute to control health care costs and accelerate the progress of national development among the developing countries. [11] The globalization of health care service markets is driven by information and communication technologies (ICTs) extending networks of service providers beyond national boundaries. These market dynamics render more complex the design of national systems integrating services to their poorest citizens with international business in health care. The objective of this paper is to describe the emerging virtual health care infrastructures of the Indian health care system and their contribution to integrate public and private sector activities as well as individual citizens and national institutions in service delivery, education and research. This case analysis contributes to a large research program designed to develop a framework for comparative analysis of national health care system infrastructures using qualitative case research methods.

2. Research Methodology

Qualitative case research methods offer a flexible approach to the understanding of large and complex health service delivery systems embedded within their extended social context. [12,13] Taken as the relevant unit of analysis, the Indian national health care system is a complex inter-organizational network valuable to the process of scientific study as

¹ The author would like to thank an anonymous reviewer for this definition.

a critical case, particularly for analysis of the co-evolution and integration of this network under a democratic ideology. Despite recognition of the importance of systems science in medical informatics, [14] little research has focused on studies of health care at the national system level, in part because of the size and complexity of such systems and the lack of interdisciplinary consensus regarding appropriate methodologies and theoretical foundations for this important field of study. Some authors suggest that there is a pragmatist epistemic argument for use of qualitative and mixed research methodologies in the field of medical informatics [15] as clinical practice is a hybrid sociotechnical field. This view rejects belief in a single “scientific method” and recognizes that research is always situated in a particular context.

This study contributes to development of a methodology and conceptual framework for comparative analysis of the virtual infrastructures of national health care systems. [6,16-19] Health care is defined as the preservation of mental and physical health by prevention or treatment of illness through services offered by the health professions. A health care system is a dynamic set of interconnected individuals, institutions, organizations, and projects offering products and services in health care markets. More specifically, “The health system encompasses all the organizations, institutions and resources that are devoted to producing health actions whose primary intent is to improve health.” [20] (p. 1) The functions of the health system include all categories of service delivery, resource generation and allocation, and governance. Governance includes both policy making and regulation of the system. Service delivery encompasses information, research, and education services as well as public health and delivery of patient care, both preventative and curative. These functions, as well as their interrelations, are critically important to the performance of an integrated health care system and the quality of health care services.

Data are drawn from published accounts of system development and the websites of the constituent organizations, networks and services to describe the configuration of virtual infrastructures. The context of the case analysis is developed using historical data to show how the current system has unfolded over time. E-mapping software² is used to visualize the linkages among institutions and resources identified in the case analysis. Electronic linkages among Indian institutions and services are considered in the analysis as well as linkages integrating the Indian system with international institutions. Using this specialized

software, an online database includes a dynamic electronic representation of virtual infrastructures identified in the study.³ Visualization of data reveals how information resources are linked and integrated in development of the virtual infrastructure. [23,24] These data describe configurations of web-based services revealing patterns associated with electronic markets and hierarchies.

3.The Indian Health Care System: Context

The Indian health care system serves a vast population estimated at 1.16 billion as of July, 2010 according to the CIA World Factbook.[21] Life expectancy at birth is 66.46 years while infant mortality is 50.78 deaths/1,000 live births and the average fertility rate is 2.65 children born/woman. About 61% of the population are literate with a significantly different rate of literacy for men (73.4%) and women (47.8%). English is widely spoken while Hindi is the national language spoken by 30% of the population and there are fourteen other official languages.⁴ There is a wide cultural and economic diversity among the 28 Indian states and 7 union territories. (Jurisdictions are further subdivided into 606 districts and 6342 blocks) It is estimated that 52% of the labor force are engaged in agriculture, while about 25% of the population live in poverty.[21] Indicators of the performance of the Indian health care system show a decline in general government expenditure on health as a per centage of total expenditure - to only 4.4% in 2002, while over 70% of the population choose private services for primary care and 40% choose private hospitalization. [22]

Since India gained independence from Great Britain in 1947, government efforts have been focused on creating and reforming the vast institutions of the health care system. [23] Following the Bhore Committee Report presented in 1946 on the eve of Indian independence, [24] the system has evolved through three generations of reforms. [25,26] The Health Survey and Development Committee, headed by Joseph Bhore prepared a detailed plan of a National Health Service for provision of universal free access to health services to the Indian population. This principle remains at the foundation

² See The Brain - Visual Information Management at <http://www.thebrain.com/>

³ See Virtual Health Care Infrastructure – India at <http://webbrain.com/brainpage/brain/986150AC-9E54-66DB-5710-692F2DBFF067/>

⁴ These other official languages are : Bengali, Telugu, Marathi, Tamil, Urdu, Gujarati, Malayalam, Kannada, Oriya, Punjabi, Assamese, Kashmiri, Sindhi, and Sanskrit

of the Indian health care system, although its promise has never been realized. [23]

In 1952 the primary health care strategy was implemented according to the Bhore Committee recommendations through the creation of primary health centres and subcentres. This infrastructure was extended through the rural development program. The priority during this period was to educate Indian health care service providers and to build the infrastructure to serve the vast Indian population. The Indian National Informatics Center has contributed to development of infrastructures for health care and rural development since it was founded in 1975-1976. [27]

In 1983 the formulation of the National Health Policy marked the beginning of the second generation of health system reforms for universal access to services and the goal of “health for all”. With a particular focus on rural health care, the goals of the 1983 policy were to offer one public health centers per 30,000 population and one subcenter per 5,000 population. While these goals have been generally achieved, the performance of the centers has been compromised by lack of resources and appropriate training. Rapid growth of the private health care sector with emphasis on curative medicine also shifted the focus away from development of public health services and preventive care. [23]

The third generation of reforms began in 1991 and was confirmed with publication of the World Development Report in 1993 by the World Bank. This period has been characterized by system decentralization as well as increased partnership with the private sector, donors and NGOs supported through contributions by the World Bank, the European Union, USAID and DFID. The participation of large donors has challenged public sector sustainability as well as the integration of the public and private sectors of the Indian national health care system.

Since publication of the World Development Report in 1993, [28] efforts have been focused on health care system decentralization through democratic representative bodies or Panchayati Raj. The Ministry of Panchayati Raj⁵ was created in 2004 to formulate action plans to empower Panchayati Raj Institutions (PRIs) as institutions of local self-government for economic development and social justice in their jurisdictions.

Decentralization is defined as “a political process whereby administrative authority, public resources and responsibilities are transferred from central government agencies to lower-level organs of government or to nongovernmental bodies, such as community-based

organizations (CBOs), third party nongovernmental organizations (NGOs) or private sector actors.” [29] p.4. Three powers are involved in transfer: 1- allocation and distribution of public resources, 2- implementation of programs and policies, and 3- generation and budgeting of public revenues. The Planning Commission of the Government of India points out in the Approach Paper to the Tenth Five Year Plan that adequate powers must be delegated to the PRIs so that they are able to address poor performance of local health care service delivery. [30]

Democratic decentralization institutes citizen control over policy-makers through elections, voting and majority rule. PRIs play an essential role in assuring the accountability of health service institutions at the local level through a process of “communitization.” [31] As more than 75% of the population lives in small villages – the majority of which have less than 1000 inhabitants - PRIs must extend to the village level of community. In the current Indian context, “communitization”, decentralization and public-private partnership frame the emergence of virtual infrastructures accessible on the Internet at the national, state and local levels of analysis. .

4. Case Analysis

The Indian infrastructure shows configurations associated with the functions of governance, information, research, education and service delivery in the public and private sectors as well as through nongovernmental and volunteer organizations of civil society. Figure 1 shows a visualization derived from the [database](#) on virtual infrastructures of the Indian health care system. The linkages identified in the database may be explored on the axes of the Indian Government, civil society portals, private health care service providers, and sectorial service gateways. In the public sector a hierarchical structure of linkages defines the configuration, while in the private and nongovernmental organization (NGO) sectors infrastructures evolve under changing market dynamics. [16]

4.1 Public Sector

The Eleventh Five Year Plan published by the Indian government calls for development of the National Grid⁶ integrating services in health care as well as other economic sectors. [32] This infrastructure augments the existing fiber optic

⁵ See the website of the Ministry of Panchayati Raj at <http://panchayat.nic.in/>

⁶ See <http://www.garudaindia.in/> and <http://www.euindiagrid.eu/>

backbone and satellite communication networks to support health care services. Another important government initiative (March 2006) affecting virtual infrastructures for health care services is the Unique Identification (UID) Project⁷ with the mission to issue a unique biometric identification to every Indian citizen and to provide easily accessible electronic authentication for such identification.

The public sector configuration includes the portal of the Government of India⁸ with links to the ministries of Health and Family Welfare⁹, Rural Development¹⁰, and Local Government (PRIs)¹¹. Under the Ministry of Health and Family Welfare are the departments of Health,¹² Family Welfare,¹³ and Indian Medicine (AYUSH).¹⁴ Also included are the National Informatics Center¹⁵ under the Department of Information, the Indian Council of Medical Research,¹⁶ and the Indian Medlars Center¹⁷ serving the information and research requirements of the Indian medical community. This configuration encompasses the functions of government and oversight of the systems of Indian¹⁸ and Modern medicine as well as infrastructures for state and local government. The linkages in this configuration are extremely complex particularly since they are the result of the historical evolution of the institutions involved.

Collections of medical research publications and other information are freely available through the Indian Medlars Center to address the needs of the Indian medical community. Linked to the Medlars Center are the MedInd and OpenMED initiatives. The MedInd webpage¹⁹ offers 38 full text journals publishing a broad spectrum of research directly pertinent to Indian medical education and practice. OpenMED offers an open access archive of publications in medical and allied sciences, including bio-medical, medical informatics, dental, nursing and pharmaceutical sciences.²⁰ The objective of OpenMED is to offer authors a free opportunity to self-archive

their publications for improved impact. The philosophy of this enterprise is open access with a liberal acceptance policy for submissions. The Indian Medlars Center also provides access to a tool for searching the resources of IndMED and PubMed. The infrastructures of these initiatives create open information markets for dissemination of information and research publications in support of research, education and service delivery.

The Ministry of Health and Family Welfare encompasses administrative and control functions over the systems of both modern and Indian medicine generally including research, education, and service activities. The virtual infrastructures of this Ministry provide detailed listings of hospitals and educational institutions²¹ as well as access to legal information and administrative forms regarding the public institutions of health care regulatory councils and implementing directorates. These infrastructures also offer forms for feedback or grievances as well as discussion forums for visitors.

The Indian Council of Medical Research presided by the Minister of Health and Family Welfare manages both intramural and extramural research programs aligned with the health priorities identified in national policies. Intramural programs are conducted by the 21 permanent specialized institutes under the Council,²² while extramural programs are proposed by scholars in their fields of expertise and reviewed by the Council. Several of the permanent institutes associated with the Council are WHO collaborating centers. The websites of these institutes offer rich information about their programs and achievements.

It is important to note the roles of the ministries of Health and Family Welfare, and Rural Development in creating Internet infrastructures to promote participation of the Indian population at state, district and local block levels. These initiatives are reflected both at the national and local levels in both public and private enterprise. At the central national level, the National Informatics Center has created a portal for access to state and district infrastructures.²³ Initiatives such as the Community Information Center of the Northeastern States,²⁴ have made progress in developing appropriate content. For example this information center makes available health education content for the continuing training

⁷ See <http://uidai.gov.in/>

⁸ See the government portal at <http://india.gov.in/>

⁹ <http://health.nic.in/welcome.html>

¹⁰ <http://rural.nic.in/>

¹¹ <http://panchayat.nic.in/>

¹² <http://mohfw.nic.in/depth.htm>

¹³ Department of Family Welfare at <http://health.nic.in/mmenu.htm>

and its associated research institutes at

<http://health.nic.in/fsresins.htm>

¹⁴ <http://indianmedicine.nic.in/>

¹⁵ <http://home.nic.in>

¹⁶ <http://www.icmr.nic.in/>

¹⁷ <http://indmed.nic.in/>

¹⁸ Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) at <http://indianmedicine.nic.in/>

¹⁹ Indian Medlars Center – medIND : Biomedical Journals from India at <http://medind.nic.in/>

²⁰ OpenMed@NIC open access archive at <http://openmed.nic.in/>

²¹ See for example the Medical Education Division of the

Department of Health at <http://mohfw.nic.in/AAamed.htm>

²² See the list of permanent institutes at

<http://www.icmr.nic.in/institute.htm#Permanent%20Institutes/Centres>

²³ See the Districts of India webpage at <http://districts.nic.in/>

²⁴ <http://www.cic.nic.in/>

of doctors.²⁵ At the same time, it offers a block level infrastructure for local governance.²⁶ This project employs center personnel, while other initiatives such as n-Logue [33] Drishtee,²⁷ and TaraHAAT²⁸ invite the application of entrepreneurs to manage kiosks accessible to local populations. [34]

4.2 Nongovernmental and Volunteer Organizations

Concurrent processes of decentralization and privatization have profoundly affected the diverse institutions of the Indian health care system. Accountability of democratic institutions is strengthened by the parallel presence of a strong civil society mobilizing voluntary action including domestic and international nongovernmental organizations (NGOs). [29] A non-governmental organization (NGO) is a legally constituted organization that operates independently from any government. The growth in number, scale and diversity of these organizations fosters new virtual infrastructures to facilitate market dynamics in the volunteer sector. NGOs favour local accountability through broad local participation as well as empowerment of marginalized and poor constituencies through alliances and networks bringing resources into the community. NGOs constitute increasingly pervasive and powerful networks of actors contributing to the process of health care service delivery.

In India, a relatively large proportion of NGOs are indigenous organizations with the participation of middle or lower class professionals or quasi professionals who either work with the poor or distribute financial support to community-based or grass-roots organizations. [35] (p. 333) These organizations may play roles to empower the poor, to contribute to their welfare, or to foster modernization and development. While some of the literature validates the proposition that the relation between the Indian government and NGOs tends to be hostile, current trends seem to indicate emergence of more complementary roles due to the objectives of decentralization and privatization of certain functions. [36]

The emerging complementary roles linking government bureaucracies and NGOs may be due in part to the usefulness of these organizations as an alternative to government decentralization. NGOs offer a not-for-profit vehicle for the privatization of the

volunteer sector of activity under varying degrees of governmental control and regulation. [37] One of the most comprehensive portals is the Voluntary Organization Database-NGO partnership program offered by the Indian Planning Commission.²⁹ Other portals, Indian NGOs.com³⁰ and NGOs India.com,³¹ propose electronic markets linking resources and NGO projects according to 608 district locations. Still other portals such as GiveIndia³² are linked to international networks. GiveIndia offers web functions for online donations and sponsorships as well as detailed information on other forms of contribution including volunteering.³³

4.3 Private Sector

Indian health care services are also available to consumers through networks of large corporate groups. Private corporate health care organizations include the Apollo Hospitals Group³⁴, Fortis Healthcare³⁵ and Max Healthcare³⁶. These groups propose medical tourism and specialized services for international patients as well as Indian citizens. Wockhart,³⁷ associated with Harvard Medical International, has the first specialty hospital (Mumbai) in South Asia to achieve U.S. Joint Commission International accreditation.³⁸

Infrastructures supporting industry-specific health care market dynamics include private health services portals such as QMed³⁹ serving information and education needs of medical professionals, and Indmedica⁴⁰ bringing doctors and patients together through onsite registry and fora for interaction between patients and medical experts. Other portals address Indian manufacturing and services more generally. Examples include IndiaMART,⁴¹ and IndiaOneStop,⁴² Through search functions and indexing these websites provide access to listings of health care service providers and educational institutions, some of which offer services to foreign consumers.

²⁹ <http://ngo.india.gov.in/>

³⁰ <http://www.indianngos.com>

³¹ <http://www.ngosindia.com/>

³² <http://www.giveindia.org/>

³³ For information on volunteering see http://www.giveindia.org/t-abtus_howcanyouhelpus.aspx

³⁴ <http://www.apollohospitals.com/>

³⁵ <http://www.fortishealthcare.com/>

³⁶ <http://www.maxhealthcare.in/>

³⁷ <http://www.wockhardthospitals.com/>

³⁸ <http://www.jointcommissioninternational.org/>

³⁹ <http://www.qmedkf.org.in/>

⁴⁰ www.indmedica.com/

⁴¹ www.indiamart.com

⁴² www.indiaonestop.com/ A search for hospital facilities yields an extensive listing at www.indiaonestop.com/hospitals.htm

²⁵ See a collection of training videos at <http://www.cic.nic.in/HealthEdu.asp>

²⁶ See the block community portals at <http://www.cic.nic.in/cicimplementsites2.asp>

²⁷ See the Drishtee Portal at <http://www.drishtee.com/cms/>

²⁸ See the franchisee application at <http://www.devalt.org/>

The foregoing discussion of the Indian health care system supported by virtual infrastructures on the Internet raises a number of complex issues including national control of health policy, and emergence of a dual standard of health care differentiating service delivery to national citizens and foreign consumers.

These concerns are critical to the Indian case due to the size and diversity of the health care system. The next section of the paper presents some conclusions and recommendations useful for future development of research on virtual infrastructures of the Indian case as well as other national health care systems.

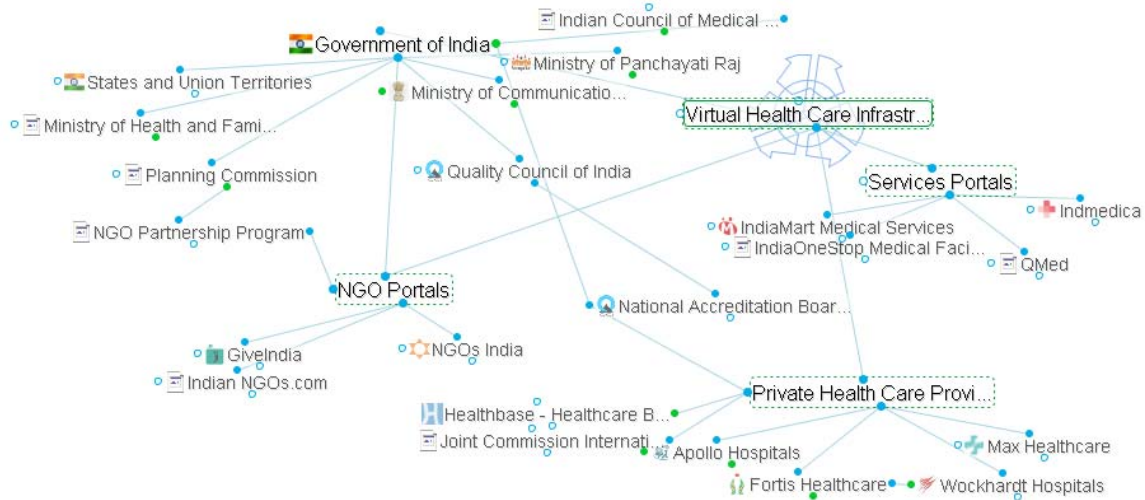


Figure 1. Virtual health care infrastructures: India

5. Discussion and Conclusions

This study has pursued the objective of identifying emerging virtual infrastructures on the axes of public, private and civil society sectors as well as their roles in the Indian health care system. The exploratory analysis reveals a dual national market system in which investments in public infrastructures such as the National Grid and the UDI will support partnerships in both public and private health services. This dual market structure also strengthens Indian research and service capacity through open access to research and information of the Medlars Center and the Indian Council of Medical Research (ICMR). [38]

The Indian health care system faces very significant challenges to effectively manage its vast scale and diversity. Emerging public infrastructures such as the National Grid along with the UID initiative are designed to integrate the individual Indian citizen in processes of national governance and service delivery. It is also important to note integration in global infrastructures in the public, private, and civil society sectors. For example, an extensive collaboration between the EU and India assures that

the Indian National Grid will become part of a larger global infrastructure for science. In the private sector, the large Indian corporate groups including Apollo and Fortis are developing international alliances for accreditation and service delivery as well as business models such as brand franchising to extend their networks. For example, Apollo has created a franchising program for its Cradle birthing service.

The challenges for national governance are reflected in the many governmental and private initiatives to promote local governance and participation by developing information websites at the district and block levels offering a variety of administrative functions as well as access to local and centralized health and other information resources. In the long run, these infrastructures will be essential to foster equitable local participation in health care policy as well as local data collection serving evidence-based governance, research and policy-making at the state, regional, and national levels. The success of local infrastructures is critical to development of health care services for two important reasons. First the effective integration of local constituencies in the public health governance system

will help to bridge the divide between citizen and international patient services, and second, local infrastructures are an essential foundation for collection of evidence and conduct of research in medicine and other health sciences.

The virtual infrastructures of the Indian health care system reveal distinct clusters serving modern and Indian medicine in certification of educational institutions and service providers trained in those institutions. The websites of the Department of Health, the Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homoeopathy (AYUSH), and the Indian Council of Medical Research (ICMR) focus extensively on issues of institutional and individual certification, publishing for example lists of accredited institutions. These structures should be better integrated with respect to research, practice and governance in modern and Indian medicine to draw together researchers and practitioners in these disparate disciplines.

There is a significant opportunity to create virtual work spaces linked to the virtual library of the Medlars Center for common consultation and collaboration. Such work spaces could provide access to international students and researchers under controlled conditions. While many of the existing government websites offer facilities such as forum discussions or citizen feedback, there is little focus on interactive educational activities such as a virtual university, or case discussions in a virtual clinic.⁴³ The creation of such infrastructures would offer new opportunities to extend the superior Indian educational and research services in health care to international collaboration.

The risk of stratification differentiating health care systems serving Indian citizens and foreign patients or consumers is increased especially by partnering of private Indian health services corporations with networks in the developed countries. Examples include Wockhardt Hospitals Group affiliation with Harvard Medical International and Apollo's affiliation with the Singapore-based Parkway Group. While these alliances offer resources consistent with international health care standards and extend the markets for Indian trade, they also create pressures that may deepen the divide between the public sector institutions and those catering to foreign markets. The most important strategy to manage this risk would be to strengthen linkages between public

health care institutions and large Indian corporate entities such as Apollo .

It should be emphasized that this study has a number of significant limitations – particularly with respect to the generalizability of conclusions or recommendations from qualitative methodology. Furthermore, the identification of virtual infrastructures with e-mapping tools does not form a basis for evaluation of use or effectiveness of such infrastructures but does contribute to a descriptive understanding of the system. This descriptive understanding suggests the critical importance of several axes of integration across virtual health care infrastructures, including system scalability (large-small scales), ideological models (social medicine-free market) and governance (local-global). Further research on these critical axes of the Indian health care system will contribute new understanding of sustainable health care services in developed as well as emerging economies.

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⁴³ Examples of such infrastructures may be reviewed at INFOMED. See the Virtual University at <http://uvirtual.sld.cu/index.html> , Virtual Clinic at <http://uvirtual.sld.cu/clinica/index.php3> , and the Virtual Library of Cuban medical journals at <http://bvs.sld.cu/revistas/>

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