
Opportunities and challenges in the deployment of global e-health

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Abstract: In developed countries, e-health has rapidly evolved from the delivery of online medical content toward the adaptation of generic e-commerce solutions to the processing of health-related administrative transactions and logistical support of clinical tasks. E-health is perceived as being particularly useful in the operational support of the new decentralised and collaborative healthcare models being implemented in many countries. Heretofore designed for large organisations and industrialised countries, e-health solutions are being increasingly proposed as an answer to the many health system management problems and healthcare demands faced by health organisations in developing societies. There are hard lessons to be learned from e-commerce, e-government, and e-health achievements and failures in developed countries and a careful examination of those experiences, *vis-à-vis* the characteristics of the health sector, organisational preparedness, and technological infrastructure of developing countries is a helpful exercise in the selection of appropriate e-health design and deployment strategies.

Keywords: developing countries; health sector; information and communication technologies; technology deployment; technology infrastructure; technology markets.

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Biographical notes: Since 1974, Dr. Rodrigues has worked in the area of health services information and communication technologies in public, private, and intergovernmental institutions in Latin America and the Caribbean, and as a Consultant for international and private organisations, multilateral agencies, and technical cooperation agencies. From 1991 to 2002, he was on the full-time staff at the Pan American Health Organization/World Health Organization, Washington DC. Adjunct Faculty at the Johns Hopkins University School of Nursing, Baltimore and at the Science, Technology and International Affairs Program (STIA), School of Foreign Service, Georgetown University, Washington, DC. He has seventy-seven publications on health informatics and information technology, health systems management, clinical medicine, pharmacology, and military medicine.

1 Introduction

Advances in information and communication technologies (ICT) and the dissemination of networked data processing have led to widespread access to information resources and globalisation of communications, businesses, and services. In the health sector, this trend is expressed by the growing consolidation of 'e-health' – an area distinguished by the combined utilisation of electronic communication and information technology to transmit, store, and retrieve digital data for clinical, educational, and administrative purposes, both at the local site and at distance [1–3]. The essence of e-health is reliable transaction delivery in a fast-changing environment involving people, processes, and a service or business infrastructure focused on the ill or healthy citizen. E-health solutions have emulated e-commerce and e-government strategies and experiences in using internet-based networked technologies to rethink, redesign, and rework how businesses and public services operate and, typically, have been aimed at the improvement of productivity, effectiveness, and efficiency, both internally and in the external relationships with clients, customers, suppliers, and partners.

Among leading digital technologies, internet-based ICT solutions have brought the greatest impact and they are rapidly changing the way health organisations, providers, care plans, payers, regulators, and consumers, access information, acquire health products and services, deliver care, and communicate with each other [4,5]. Emerging e-health applications are oriented to professional networking, integration of the clinical care process management, and the provision of web-based health information and patient care, including remote monitoring and healthcare. This expanded view of e-health has been promoted as the final stage in bringing online the entire healthcare industry.

2 Social, economic, and organisation challenges faced by the health sector

In developed and developing societies, the health sector faces two demands: firstly, to provide expanded and equitable access to quality services and, secondly, to reduce or at least control the rising cost of healthcare. Changing demographics, particularly age structures and lifestyles; urbanisation and industrialisation; and growing demand for better access to patient-oriented quality care have been the main drivers in the reorientation of health systems in every country. Shifting epidemiological profiles are putting an increasing burden on healthcare services and on the society – in high- and middle-income countries, about 40% of the population has one or more chronic conditions and in many societies, chronic conditions account for up to two-thirds of healthcare expenditures. In each care setting, a limited set of health conditions account for most of the cost due to the mounting demand for high-cost diagnostic and therapeutic resources.

In developing countries, a considerable number of preventable diseases and premature deaths, both in absolute and relative terms, do still prevail and there is greater inequity of access to basic health services resulting in regions, communities, and social groups being left without access to the most basic level of care. In most countries the health sector is underfinanced – this has led to quantitative and

qualitative deficiencies in service delivery and to growing gaps in facility and equipment upkeep. Inefficient allocation of scarce resources and lack of coordination between health subsectors, institutions, and other social agents and stakeholders with duplication of efforts, overlapping responsibilities, and resource wastage are common and troublesome problems.

3 Trends in the organisation and delivery of healthcare

Most countries are at some stage of reform, aimed at introducing substantive changes into the health sector and in the relationships among stakeholders and the roles they perform, with a view to increasing equity in benefits, efficiency in management, and effectiveness in satisfying the health needs and expectations of the population [6]. Those new models of care require innovative functions and fresh responsibilities for users and providers and the increased involvement of local governments and non-traditional professional categories. Competition, merger of provider organisations, aggressive contracting by payers, and rising involvement of employer and public purchasers have characterised the changing processes occurring in health services management.

Health reform processes have many facets and there is no single model being adopted by all countries. Each country is moving at a different pace in the implementation of its own particular health system model but the economic and globalisation changes of the last years have brought a new urgency to the reform processes. There are, however, common trend-setters and responses that characterise most health sector reform processes:

- the universalisation of a high cost–benefit basic package of health services
- a set of standardised public health interventions
- cost containment and recovery
- administrative decentralisation and operation of healthcare services
- recognition of the role of the private subsector and the intersectorality of health interventions
- health models oriented towards primary care and centred on people
- focus on quality and accountability
- moving away from the reactive delivery of care to a more proactive management approach of the health status of individuals and population groups [6,7].

4 E-health and the new models of healthcare organisation and delivery

In this environment, the business imperative for e-health is concrete, is driven by the operational requirements of health reforms, and is aligned to many of the determinants found to be relevant in e-commerce [8–10]:

- growth of a global marketplace and the ubiquity of interactive communications
- networks of producers, suppliers, customers, and clients
- global demand for telehealth services is estimated to be of US\$1.25 trillion, of which about two-thirds is for direct services and the rest for second opinion, consumer information, continuing education, management and other services
- leasing, membership, service agreement, and strategic alliance models replace traditional business organisations based on ownership of physical assets and long-term structures
- lifetime value of customer retention replacing 'one time sell'
- economies of speed, forecasting demand, and customer service and satisfaction replacing economies of scale and impersonal service provision
- customisation capable of achieving a 'one of a kind' product or service
- levelling effect by reducing entry barriers, thus allowing small firms and poor countries and populations to have access to markets, information, and other resources, and therefore balancing the vertical integration competitive advantage of large corporations.

Advanced ICT resources have been recognised as essential for operational support and management of the new health and healthcare models [7,11–14] and they must address the needs of the new trends in healthcare that emphasise a continuous relationship between providers and clients; customisation of care; expanding partnering of providers, insurers, and clients; increasing client control of evidence based-health decisions; information that is not frozen in records and kept in separate sites with access limited to their creators but available to all stakeholders; and transparency and cooperation instead of independent professional roles. However, in order to reap the full benefits of such innovative data processing, communication, and use, it is necessary to have a clear definition of goals; effective collaboration among stakeholders; appropriate technology infrastructure, systems integration, and standards; and the implementation of performance metrics.

5 Challenges to the deployment of e-health in developing countries

5.1 Socioeconomic and development constraints

Technology distribution and access deficiencies represent the most acute issues in the dissemination of e-health applications. In a more limited focus, the 'digital divide' encapsulates the dramatic worldwide variation in access to computer-based information technologies, typically measured in terms of teleaccessibility, personal computer ownership, and internet connectivity available to individuals and communities (Table 1).

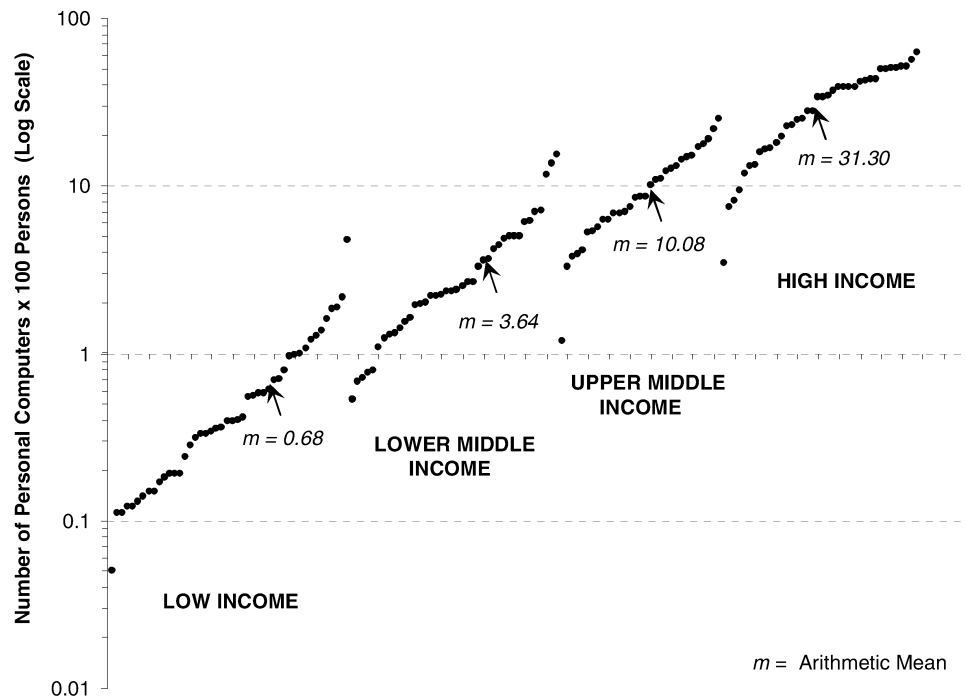
Table 1 Teleaccessibility and information technology distribution for the year 2001

<i>Countries</i>	<i>Main telephone lines per 100 persons</i>	<i>Residential main lines per 100 households</i>	<i>Monthly subscription as % of income per capita</i>	<i>Personal computers per 100 persons</i>	<i>Internet users per 10,000 persons</i>	<i>Internet hosts per 10,000 persons</i>
Low income	2.9	11.4	14.1	0.6	62.2	1.0
Lower middle income	13.6	35.8	2.9	2.4	264.9	4.3
Upper middle income	22.7	59.8	2.0	8.2	992.6	78.7
High income	59.7	108.8	0.7	37.3	3992.9	1484.2
World	17.1	54.9	5.7	7.7	820.8	232.6
Africa	2.6	9.9	12.7	1.0	84.9	3.4
Americas	35.1	80.6	3.1	26.6	2164.3	1332.9
Asia	10.7	41.8	5.5	2.2	433.9	28.7
Europe	40.5	80.0	1.1	17.9	1804.5	191.5
Oceania	40.0	98.3	3.7	39.9	2771.6	885.2

Source: International Telecommunication Union, World Telecom Indicators 2002

Digital divides, like social and economic divides, exist within and not just between societies and are integral parts of a much broader and intractable 'development divide' that include insufficient telecommunications infrastructure, high telecommunications tariffs, inappropriate or weak policies, organisational inefficiency, lack of locally created content, and uneven ability to derive economic and social benefits from information-intensive activities [15–17]. Information and communication technologies utilisation inequalities by the general population are found also in industrialised countries and have been shown to be determined by level of education and income [18,19]. The situation of technology adoption within developing countries has been of growing polarisation with segments of the population bypassed by the products of the information revolution. This is complicated by the fast-changing deployment of new technologies and accompanying standards that are constantly raising the level of advancement that must be met by anyone who wants to remain current [20,21].

Figure 1 shows how the level of personal computer ownership relates to the level of income in 155 countries – low- and middle-income countries show a greater dispersion of values among different countries when compared with the high income group of countries which average a 31% ownership level, except for the notable exceptions of Japan, Barbados, Greece, and Brunei, which have ownership levels below 10%.

Figure 1 Ownership of personal computers in 155 countries categorised by level of income

Source: Data from: International Telecommunication Union, World Telecom Indicators 2002

In the health sector, development and digital divides between industrialised and developing countries are wider than the gap observed in other productive and social sectors. In some cases, the changes brought about by the privatisation of healthcare did add to the already high degree of structural inequity that prevails in most of the low- and middle-income countries.

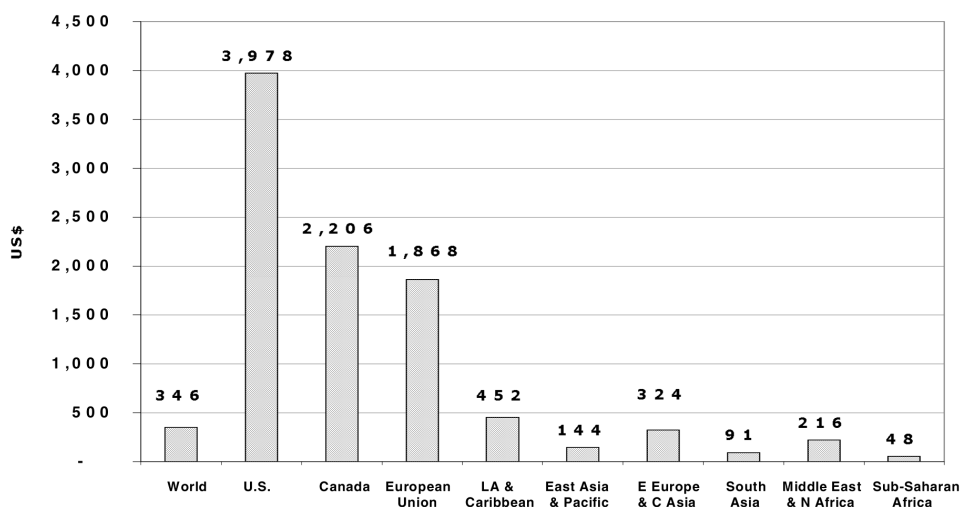
5.2 *Technology infrastructure and operational issues*

Besides achieving reliable transaction delivery, a technologically successful 'e-architecture' must provide superior client service, customisation of products and services, interactivity, and maximum convenience [22]. The deployment and operation of 'e-solutions' share technology infrastructure and operational deployment issues involving reliability of service, that directly depends on:

- degree of information preparedness and information technology insertion in society
- an appropriate and functioning network and technology platforms and physical infrastructure
- the understanding of market relationships among the different actors in the informatics and telecommunications areas
- managing knowledge about health, individual client medical history, the environment, and enterprises
- data protection measures and regulatory framework to ensure transaction security
- auditing processes that are quite diverse from traditional paper trail solutions.

Poor telecommunications infrastructure, limited number of internet service providers (ISP), lack of access to international bandwidth, and affordable internet access costs are readiness issues that continue to be major impediments to diffusion of internet applications to the point of care in developing countries. There is a marked variation on the national expenditures among countries even for countries of comparable income level [23]. The low per capita expenditure in health (Figure 2) limits the market for new and expensive technologies.

Figure 2 Global health expenditures per capita for the period 1998–2000 – expressed in 1999 International US dollars (purchase power parity)



Source: Casas [23]

Per capita expenditure in ICT is a better indicator of the real level of investment than expenditure as percentage of the gross domestic product (GDP). Some developing countries have expenditures that are comparable to that of developed countries when expressed as percentage of the GDP, although the absolute value per capita is low – for instance, relative to its GDP, Brazil has the same level of expenditures as Canada, although in absolute value Brazil invests 6.6 times less than Canada in ICT (Table 2).

Table 2 Expenditures on information and communication technologies in selected countries

<i>Country</i>	<i>ICT expenditures per capita in US\$ (2000)</i>	<i>ICT expenditures as % of GDP (2000)</i>	<i>Country</i>	<i>ICT expenditures per capita in US\$ (2000)</i>	<i>ICT expenditures as % of GDP (2000)</i>
Argentina	317	4.1	Hungary	431	8.7
Australia	1992	9.7	Italy	1068	5.7
Austria	1697	7.2	Japan	3118	8.3
Belgium	1769	8.0	Mexico	189	3.2
Brazil	289	8.4	Norway	2445	6.9
Canada	1911	8.4	Russia	63	3.7
Chile	360	7.8	Singapore	2104	9.7
China	46	5.4	Spain	731	5.1
Colombia	228	12.0	Sweden	2674	10.4
Finland	1835	7.8	UK	2187	9.1
France	1916	8.7	USA	2296	8.1
Germany	1798	7.9	Venezuela	196	3.9

Source: World Bank, 2002 World Development Report

Dependable connectivity is needed for reliable transactions. In developing countries fast connectivity is still limited and usually only dialed-up access is available. As an example, a study across different industries showed that only about one-third of the connected organisations in selected lower- and upper middle-income Latin American countries had access to connection speed higher than 56 Kbs (Table 3).

Table 3 Connectivity speed in selected countries of Latin America

<i>Countries</i>	<i>Organisations with Access > 56 kbps (%)</i>
Mexico	42
Peru	39
Chile	37
Brazil	33
Argentina	31
Colombia	31
Venezuela	27
Ecuador	22
<i>Regional average</i>	35

Source: Harte-Hanks CI Technology Database, 2001

The access site problem can be further illustrated by the result of a 1999 survey of 42,744 physicians in Brazil. The study revealed that 52% used the internet – a level of diffusion equivalent to the general US population – however, when 23,603 physicians users were asked from where they predominantly accessed the internet, 85% indicated their home, 10% the office, and only 2–3% indicated the site as the university or the hospital, respectively. In comparison, US physicians have the following web access profile: 40% at the workplace, 56% at the office, 87% at home, and only 7% were not connected.

On a positive note, telecommunication sectoral reform in developing countries is bringing significant improvements in services and a drop in tariffs as a result of greater competition and expanding markets. With the recent rapid trade liberalisation and modernisation of the telecommunications sector in many countries of the developing world, the telecommunications infrastructure is improving. One-fourth of the 89 major public telephone operators that were privatised throughout the world by the end of 1999 occurred in Latin America and the Caribbean [16].

5.3 Imperfect markets

In many developing countries the market for ICT products and services is limited. The hospital subsector is characterised by small facilities – e.g. in Latin America and the Caribbean 60.5% of the hospital facilities have 50 or fewer beds (Table 4) – that cannot afford the major capital expenses in deploying ICT resources and would be hard-pressed to meet the operational costs to maintain in-house applications.

Table 4 Hospitals in Latin America and the Caribbean by number of beds

Number of beds	Hospitals		Beds	
	<i>n</i>	%	<i>n</i>	%
1–50	10,027	60.5	219,383	20.0
51–100	2615	15.8	189,559	17.3
101–200	1703	10.3	242,770	22.1
201–300	544	3.3	133,225	12.1
301–400	242	1.5	84,811	7.7
401–500	133	0.8	58,951	5.4
501–1000	186	1.1	126,169	11.5
> 1000	29	0.2	43,097	3.9
Sub-total	15,479	93.4	1,097,965	100
No data	1087	6.5		
Total	16,566	100.0		

Source: HSP/HSO Directory of Latin America and Caribbean Hospitals, 1996–1967

Web-enabling business and government operations is expensive. The US can be used as a case example: internet-based marketplaces can lower operational costs and improve efficiencies but deployment expenses will ordinarily cost a typical business US\$5.4 to 23 million over 5 years. Required procedures involve changing procurement processes, integrating online and internal systems, buying applications, and paying transactions fees and intermediaries. In general, such costs have the following distribution: 32% for internal preparation; 26% for initial contracts and fees; 20% for ongoing internal management; and 22% for ongoing fees and external services [24]. It is difficult for health executives, particularly in the public sector, to justify such levels of investment. There is no comprehensive data for health ICT expenditures in developing countries.

The straightforward transference of the e-commerce experience and solutions to the health sector is also problematic because the healthcare environment has characteristics that are quite different from an 'ideal' competitive market, guided by rational decisions and the balance of availability and demand for goods and services. Such differences include: social goals of the health sector (equity of access and quality of care); restricted number of producers (healthcare providers); self-interest is the main guiding force for providers and consumers (patients); provider makes most of the 'buying' decisions (information asymmetry); many barriers to entry; monopoly supported by regulatory and legal instruments; branding is generalised (providers, pharmaceuticals); multiple uncontrolled externalities; and high risk and uncertainty or irreversibility of outcomes. Moreover, in the health sector there is low price elasticity for goods and services determined by scarce resource input, costly processes, and unequal distribution requiring allocation decisions; provider-induced supply and demand; monopolies and economies of scale are difficult to circumvent; and constant conflict between managers and providers regarding efficiency issues, resource use, and cost control measures.

5.4 Entry barriers for service providers and firms

Many market segments are becoming increasingly ICT-dependent as part of globalisation [9,25–27] and the success of developed countries, particularly the US, in taking advantage of ICT partly reflects its flexible and competitive markets. Possibly, smaller benefits can be expected in more regulated economies or in the case of implementation environments characterised by rigid labour, trade, and inefficient commodity markets and capital exchanges [28].

Cross-border challenges are particularly pressing due to the growing number of national, international and non-governmental actors involved in transnational and global concerns. Areas of concern in the introduction of electronic marketplaces, particularly in developing countries, are related to the difficulties in regulating offshore business, the dominance of the internet global communications infrastructure by a few countries, and a growing concentration of power and knowledge in few corporations. As is usually the case with innovation, the agents that first move into the market quickly attain a dominant position, block the entry of new competitors, and capture a large part of potential proceeds. Although businesses and public organisations are adapting at various speeds to new processes and models, the organisational 'culture', and the nature, and frequency of those business

environment changes may create friction, undesirable impacts, and personal behaviours that may impede the consecution of the project expected results. The results of the experience with e-commerce and e-business over the last 2 years clearly show that the emergence, adaptation, and real-world deployment of new technologies is a complex issue teeming with uncertainties.

Unfounded vendor-driven expectations of how the internet will revolutionise healthcare have too often overshoot their target [29]. Overestimation of results and consequent unfounded expectations is a common pitfall. A common error has been to regard technology as the solution for logistical, administrative, and knowledge management problems of healthcare. The lesson to be learned for e-health is that technology can be justified economically only if organisations deploy it in a real practice environment and closely track how managers and direct care professionals are using it. This requires the stepwise development and implementation of processes and metrics to monitor productivity and impact [3,29–31].

Market capture by strong, organised, and well-funded health provider organisations, some of an international nature, is happening at a fast pace and regulatory methods have been advocated to safeguard local competition. Those highly specialised, closed, and regulated areas are being swiftly opened to new players in a marketplace that is still mostly unregulated and, at the same time, when novel and untried health reform models are being introduced. Intangible health ‘e-solutions’ products and services offered by foreign providers, as in the case of investment, insurance, knowledge dissemination, and healthcare applications, present great challenges to developing and poorly developed countries and may result in flight of capital, tax evasion, employment reduction, capture of the health market, and ‘cultural colonisation’.

Intellectual property has been a major area of concern and conflict. In the area of information technology the emphasis of intellectual rights has changed from the protection of the author/inventor to that of the investor. Implications for developing countries, welfare effects, foreign investments, transfer of technology, and impact on domestic markets are difficult to foresee particularly in relation to foreign direct investments and technology transfer [32]. The universalisation of standards for intellectual property rights protection has been enabled by the World Trade Organization General Agreement on Trade and Services (GATS) adopted in 1995 at the Uruguay Round of negotiations reinforcing protection in three key information technology areas: computer programmes, databases, and layout design of integrated circuits. Stakeholders concerned with such issues include: nation-states; multinational business organisations; subregional trade blocks, and integration groups. Some of these entities are being increasingly overwhelmed by market access challenges not envisioned before the diffusion of ICT.

Limiting acquisition of innovative technology only to those that are captured by the patent system (‘inventions’) makes a society permanently dependent of external sources. Even countries with significant high technology export have shown a negative balance of royalties and license fees representing a net transfer of resources to developed countries, particularly the US (Table 5).

Table 5 Technology exports, royalties, and licenses payments for the Year 2000

<i>Income Groups/ regions/ selected countries</i>	<i>High technology exports as % of all manufactured products</i>	<i>Royalties and licenses income in millions of US\$</i>	<i>Royalties and licenses payments in millions of US\$</i>	<i>Royalties and licenses balance in millions of US\$</i>
Low income	7	105	1108	-1003
Middle income	16	1768	9956	-8188
Lower middle income	14	526	3265	-2739
Upper middle income	17	1242	6691	-5449
Low and middle income	16	1873	11,064	-9191
East Asia and Pacific	25	784	5409	-4625
Europe and Central Asia	10	313	1753	-1440
Latin America and Caribbean	16	501	2666	-2165
Middle East and North Africa	1	106	614	-508
South Asia	3	87	338	-251
Sub-Saharan Africa	8	82	283	-201
High income	22	70,321	62,988	7333
USA	34	38,030	16,100	21,930
Europe (European Union)	16	11,019	23,422	-12,403
Japan	28	10,227	11,007	-780
World	29	72,194	74,051	-1857

Source: World Bank, 2002 Development Indicators, modified

5.5 *Skilled and committed human resources are essential*

People are central to the value-added creation of e-health products and services and an organisation's human resource is the key to success [3]. Employees' skills are the most expensive and least elastic resource and an obstacle to technological development in developing countries. Systems professionals and technology products and services providers and project team must have superior skill levels and experience in the particularities of the area being automated. The number of technicians, scientists, and portion of the GNP devoted to research and development is a good indicator of those capabilities (Table 6).

Table 6 The research and educational divide: selected technology inputs by region (1992–1997)

<i>Region</i>	<i>GNP per capita US\$</i>	<i>R&D as % of GDP</i>	<i>Technicians per 10⁶ population</i>	<i>Scientists per 10⁶ population</i>
OECD countries	20,113	1.8	1326.1	2649.1
Eastern Europe & FSR	4027	0.9	577.2	1841.3
East Asia	6270	0.8	235.8	1026.0
Latin America & Caribbean	5635	0.5	205.4	656.6
Middle East	8941	0.4	177.8	521.0
Sub-Saharan Africa	1971	0.2	76.1	324.3
South Asia	1764	0.8	59.5	161.0

Source: Rodríguez, F. and Wilson, E., InfoDev/World Bank 2000, modified

The most successful efforts to incorporate information and communication technologies have occurred in countries with strong and efficient government and academic institutions committed to invest in education, scientific and technological development, and public services, in tandem with business sectors (for instance, banking and retail commerce) ready and willing to automate their operations.

5.6 Public health authorities frequently have a misguided vision of ICT

Despite the fact that the health sector is key to the welfare of the population and the formation of human capital, the sector has not kept pace with the momentum of change that has been experienced in recent years in other areas of economic, political, and social life, even in developing countries. Most public health organisations in the developing world are not taking advantage of existing ICT opportunities and most existing information systems are inadequate to the requirements of the new models of healthcare being deployed in the context of health reform initiatives. Besides the common perception among physicians that health information systems are mostly a source for scientific and technical information, often public health authorities have a view of clinical–administrative information systems that is obsolete and frozen in a ‘statistical–epidemiological’ archetype, designed for the collection of numerical data representing only counts of events and mostly generating only highly aggregated statistical data and time series related to mortality, morbidity, and to service utilisation and coverage. Those information systems have very little practical interest to direct care professionals and unit managers and are far behind in providing the logistical and longitudinal individual client-based data required to operate and manage the sort of healthcare models being deployed in many countries.

Worse still, most public health authorities are totally oblivious to the broad variety of possibilities offered by modern information and communication technologies to manage client-based data, support operations, and mine large databases. Indeed, the health sector has not applied the range of options provided by information and telecommunication technologies as effectively as have other social sectors, and health has been conspicuously under-represented in national technology

development policies and plans. Such concerns have also been raised by traditional national statistics organisations in developed countries [33].

As a counterpoint to the passiveness of the public sector, the private providers and managed care groups recognised that a 'different' type of information system and data elements are required to run their organisations and survive in a competitive environment driven by increasing consumer demands and expectations and for the delivery of personalised evidence-based services. Besides using ICT resources to boost productive specialisation, such as allowing the efficient use of diagnostic services and consultations, the maintenance of integrated records, reduction in the number of specialists, and attaining economies of scale by linking to national and international markets, there are many new areas of application that are rapidly gaining ground and reducing care costs while improving the continuity and quality of care [34–36]. The lack of involvement of public sector stakeholders in the use of ICT is worrisome. At a time when, in many countries, the ailing, bureaucratic, and inefficient public sector is struggling against poorly regulated privatisation of social services, there is a clear danger in that their inaction in adopting ICT solutions may indeed hasten the further reduction and even the demise of public health services incapable of competing with an IT-enabled private sector.

5.7 Standardisation is a prerequisite

As providers and insurers soon realised, the simple automation of current processes and services and putting them on a web-enabled environment is not feasible [3]. A great amount of work has been done in the creation and promotion of data-related standards [11] and despite the lack of standards in some areas, fortunately there are solutions that allow different organisations and systems to communicate through standardised open access internet software languages. Process and data standards for the healthcare industry involving all constituents – employers, consumers, providers, payers, and regulators – promoted by accrediting organisations have facilitated the adoption of common procedures and routines. A certain amount of standardisation also has been driven by regulatory action. In the US the introduction of the Health Insurance Portability and Accountability Act (HIPAA) regulations forced a reluctant health industry to adopt uniform formats for health data exchanges and uniform code sets to identify internal and external health services activities and to be HIPAA-compliant became a requirement of all applications. However, even in developed countries the lack of national standards for unique person identification has slowed implementation of patient-based information systems. An extensive review and reference source on healthcare data standards was published by the Pan American Health Organization [11].

5.8 Security and privacy are major concerns

Data security and privacy of personal health data are universal concerns and a high-priority issue in many countries. There is a growing concern regarding the protection of health records against intrusion, unauthorised use, data corruption, intentional or unintentional damage, theft, and fraud. Health data transmitted over national and international networks offer unprecedented opportunities for better patient care and community health interventions by facilitating data exchange

among professionals but pose new challenges to confidentiality. The promise of internet to improve care by timely access to the right information can only be realised through secure connections shared across all platforms.

Given the sensitive nature of healthcare information, and the high degree of dependence of health professionals on trustworthy records, the issues of reliability (data residing in the electronic health record are accurate and remains accurate), security (owner and users of the electronic health record can control data transmission and storage), and privacy (subject of data can control their use and dissemination) are of particular significance and must be clearly and effectively addressed by health and health-related organisations and professionals. Reliability, security, and privacy are accomplished by the implementation of a number of preventive and protective policies, tools, and actions that address the areas of physical protection, data integrity, access to information resources, and protection against unauthorised disclosure of information. A comprehensive review and reference source on personal data protection regulation was published by the Pan American Health Organization [37].

5.9 Quality of publicly available information

This is probably one of the most serious issues in the area of internet-based interactive health communications. The internet offers unprecedented power to provide all users of healthcare information – patients, professionals, families, caregivers, educators, researchers, insurers, regulators, and policymakers – with data of unprecedented timeliness, accuracy, depth, and diversity. Yet it is equally clear that the very qualities that make the internet such a rich marketplace of ideas – its decentralised structure, its global reach, its levelling of access to the tools of publication, its immediacy of response, and its ability to facilitate free-ranging interchange – also make the web a channel for potential misinformation, concealed bias, covert self-dealing, and evasion of legitimate regulation. It is very difficult to ascertain and recommend on the credibility, motives, sponsorship, and eventual conflicts of interest in the more than 50,000 health websites in existence. Many health public-oriented websites are profit-driven, others promote unproven and even dangerous forms of treatment or products, while others may be good intentioned, but contain misleading or false information [36–49].

6 Recommendations on policy, strategies, and organisational issues for the deployment of e-health in developing countries

The current health sector organisational structure and national regulatory framework in developing countries are not conducive to problem-oriented, interdisciplinary, rapid-response collaborative technical work, and the concomitant implementation of the political, regulatory, and managerial tasks required to address multifaceted and complex technological problems.

To move ahead with the deployment and use of e-health, coordinated actions must be conducted in the context of a framework that links public, private, and social efforts to speed the development and deployment of priority ICT solutions. Technical knowledge, experience, and financial investments needed to establish large and complex information system projects require tapping into resources and expertise that no single organisation retains. Public and private institutions, academic organisations,

the industry and financing agents must find ways to pool their assets through project partnerships and add social value to applications of informatics by providing new employment opportunities, socioeconomic development, educational opportunities, promoting health, and supporting cost-effective health services.

The attainment of this mandate involves the participation of a large number of stakeholders, but the coordinating effort will necessarily concentrate on the public sector. Governments must grapple with the many transnational and global e-health issues and address them in a comprehensive and collaborative manner. Notwithstanding, broad objectives are difficult to achieve and the best strategy is to start by identifying the most repetitive tasks associated to significant costs – e.g. the automation of claims and reimbursement procedures – and then proceed to other areas.

6.1 Developing a vision and action plan

The goal of a health ICT vision and strategic plan of action is to establish a coherent national arrangement to facilitate projects and infrastructure development, maximising the benefits for invested financial resources, and enabling people to accept and function more effectively in an informed environment. The immediate objective is to promote the deployment of core e-health applications and support functions by incorporating an advanced informatics component into existing and new health programmes and projects, supported by a combination of funding programmes, incentive grant programmes, and prototype development funding programmes.

Implement rational and technologically neutral policies for public and private payers – coverage and payment policies should be established to address the entire range of e-health applications and technologies. Means should be developed for assessing the appropriateness of health services provided via telemedicine applications. Outcome-based quality improvement programmes will be of great importance in assuring quality, and cost-effective medical care. Appropriate actions will be taken to make available appropriate content to consumers, patients, and service providers with the objective of enhancing healthcare outcomes – the process for conveying quality evidence-based information should permit the user to follow the links between data, inferences, and conclusions. Authentication, access control, confidentiality, integrity, and attribution are key requirements for health-related advice and decision making.

Six priority areas are envisioned for government involvement in e-health development and deployment:

- promotion of education, training, and national planning capacity in information systems and technology
- convening groups for the implementation of standards
- sponsoring basic scientific and technological research and providing funding for prototype development
- ensuring the equitable distribution of resources, particularly to places and people considered by private enterprise to provide low opportunities for profit
- protecting rights of privacy, intellectual property, and security
- overcoming the jurisdictional barriers to cooperation, particularly when there are conflicting regulations.

6.2 *Strengthening organisational and human resources: awareness, skills, and leadership*

Health organisations must be provided with information about the opportunities as well as the risks of e-health solutions. Technology evaluation sources and results must be made available and health managers must be guided in the difficult process of systems specification, procurement, acquisition, and contracting ICT products and services. Knowledge repositories on ICT resources and solutions must be established in cooperation with the industry, centres for technology evaluation, academic research groups, and centres of excellence.

Human resources development through awareness programmes, education of health staff, continuous training, and career opportunities must be institutionalised from the inception of the developmental effort. Transference of technical expertise and the appropriation of knowledge by health personnel are necessary for the full participation of end-users in the development process and the best insurance for successful implementations. Success in the deployment of institutional e-health applications depends on the existence of staff with the right mix of skills in all functions and levels. A recommended strategy will include the following elements:

- A structured human resource development programme defined with the goal of increasing awareness of e-health opportunities and capacitating health professionals to assume a leadership role and actively participate in all aspects of systems design and implementation.
- The training strategy will take into account issues associated with the development and the organisational environment in which systems are expected to operate and the specific circumstances of the local health system. The following guidelines for training will be implemented: identify target groups on the basis of functions and training needs; develop training programmes to meet identified needs of target groups; and establish a network of training focal points, taking into account the specific organisation and circumstances of national characteristics and local health unit requirements and undertakings.
- Target groups to be considered are: those who originate, collect and supply data; operational decision makers (direct healthcare professionals and administrators); managers, planners, and policy makers; information systems managers; information technology and computing specialists; data analysts; and statisticians and researchers.
- Each country will develop its own strategy for initial and continuing training in health information systems, considering the overall development of health information systems and its particular healthcare, educational, research, and market environment.

6.3 Creating incentives through telecommunication sector reform

Many developing countries are committed to reform their telecommunications systems. They did recognise that progress in the telecommunication sector is essential to the establishment of health informatics and to ensuring the global competitiveness of their economies with a focus on market liberalisation. Recommendations include actions in the following areas: market access issues (interconnection regulation framework, clear and transparent regulation governing competition, and allocation of spectrum harmonisation); technical standards (interoperability standards and the streamlining and liberalisation of conformity assessment process for equipment certification); regulation (elimination of rules of origin and treating products from different countries equally when standards are the same, the elimination of subsidies, antidumping practices, and abolishment of countervailing duties); promoting competition (establish a regulatory framework that balances national needs in the context of creating a competitive national telecommunications system, weigh cost of delaying competition against the need for an effective transitional regime, and move towards full liberalisation as quickly as appropriate); protecting technology and intellectual property rights; and establishment of rational and affordable tariff structures.

6.4 Implementing data-related standards and a regulatory and legal framework

Standards development and implementation must be carried out with the participation of the public and private sectors to achieve consensus on a set of principles for the collection, transfer, processing, storage, and use of health data over national and global information infrastructures. Providing technological interfaces that facilitate effective use of the infrastructure and its component systems involve systems capable of rendering information from multiple modalities, in conjunction with a variety of applications as aids to health services operational support and decision making. They will require modularity and connectivity compliant with standardised interface protocols. Standards will be defined by a consortium of users, researchers, government, technical and scientific bodies, and the industry at three distinct levels: first, in terms of standardisation of data and information; second, in terms of the computational facilities required to manipulate and store the information; and third, in terms of telecommunications facilities, employed to transfer information among dispersed sites.

Legal and regulatory infrastructure must be implemented with the goal of facilitating medical communication – at the professional level, such issues as interstate/province licensure and establishing the credentials of service providers must be addressed, and legislation must be passed to ensure the protection of personal health information. To be effective and efficient, the healthcare industry must operate in a digital environment encompassing connectivity, commerce, and community/content sites. Using regulatory and legal power to nudge the health sector toward compliance is a valid and effective approach – the European and Canadian healthcare systems have used this strategy and HIPAA, the US federal Health Insurance Portability & Accountability Act, is a prime example of how the industry can be coached into complying with a variety of guidelines related to standardisation, security, and privacy – in effect, HIPAA is forcing a general e-health solution on the US healthcare industry.

Developing countries can profitably learn from those experiences in the development of regulatory mechanisms that will provide the incentives to convince the health industry in deploying efficient and cost-effective e-health applications that will move the healthcare system forward and result in real improvements in patient care and clinical practice. Legislation proposals should be initiated early in the process to ensure that the technology does not abridge patients' rights to confidentiality or security of medical records. Agreement on practice parameters must be developed to include aspects related to informed consent, physician liability, non-physician liability, reimbursement, practice parameters, and physician-patient relationships.

6.5 Financing and public-private partnerships

Given the fact that the worldwide market for information technology, products, and services is currently valued at US\$853 billion, and that worldwide investment in telecommunications infrastructure is expected to exceed US\$200 billion by 2004, developing countries need to find ways to share this growing trend. Domestic and foreign, public and private investment sources will be involved, ranging from revenue-sharing initiatives and joint ventures to direct investment, transfer schemes, a development fund established by a special tax on telecommunications, major private financial institutions, loans from international funding agencies and development banks, and incentive grants.

Joint investment and development involving users, governments, academic and financing institutions and agencies, technical cooperation agencies, and industry interests are seen as necessary. Partnerships with the informatics industry are fundamental and, in the case of general informatics tools, the industry practically drives the solutions. A concerted effort is needed to secure a clearly defined and specified partnership with the informatics industry at the global and national levels aimed at application development at acceptable cost. Investments must be attracted to the telecommunications industry by improving investment conditions, lower duties on telecommunications equipment, and pose no restriction on network design except for technical reasons to allow for new providers.

A retrospective of experiences shows that continuity and sustainability of information systems projects continue to be a major problem in developing countries. Externally funded projects frequently collapse upon funding termination and this fact demonstrates that all projects need justification in terms of cost-benefit and long-term financial sustainability besides organisational capacity to develop and implement information systems. This further indicates that spreading the financial risk across several stakeholders may be appropriate as cost sharing increases overall awareness, utilisation, and long-term potential for success.

6.6 Fostering international cooperation

In the international setting, cooperation between developed and less developed countries is essential, but special care must be taken to avoid interventionist behaviour by donor or lending agencies that ignore the recipient's real needs and expectations, fail to understand capacities, demand action without allowing sufficient time for conceptual assimilation, neglect cultural constraints, and ignore the scope of

the recipient's knowledge basis. As in many other areas of international cooperation the danger is to have too much too soon or too little too late.

A possible framework for collaborative work should include support for international health issues, healthcare reform implementation, application development, education, and economic and technological cooperation. Leading areas for technical cooperation include: priority assessment, technology evaluation and selection criteria, implementation issues, emerging technologies linking patients and providers, access to knowledge databases, consumer informatics, and the utilisation of internet and internet-enabled technologies. International aspects of e-health form a critical and urgent area still to be addressed by the World Trade Organization and regional trade blocks.

6.7 Bridging the digital divide

Only a more active role of government and public-private partnerships in supporting appropriate technology transfer and adaptation through indigenous research and development and the implementation of specific policies to protect local development will create an environment that will lead to a reduction of the present ICT development divide. Developing countries may take advantage of the accumulated knowledge and mistakes and may leapfrog developmental stages. However, this is not expected to be readily achieved due to the barriers posed by the general institutional underdevelopment, low income, illiteracy, and the financial constraints that afflict many countries. It is improbable that the bridging of the health sector development divide will be accomplished easily. In industrialised countries it took several decades and numerous institutional and organisational transformations for the consolidation of economic, institutional, and technological changes and the crystallisation of long-term structural patterns necessary in order that information and communication technologies could spread to vast sectors of the society.

Governments and international development agencies and programmes must urgently focus their work on the establishment of a telecommunications infrastructure that is comprehensive, reliable, ubiquitous, and compatible across applications – such an infrastructure must provide affordable bandwidth that is sufficient to serve the wide variety of users' specific needs. Its development will be dependent upon the continued deregulation of the telecommunications industry and will involve the leveraged use of many ICT technologies that have been spawned by and for other industries. Making information products and services available to the population in public spaces, libraries, schools, mobile computer units, and by subsidising acquisition of equipment by students and professionals requires a level of investment that many countries cannot afford. By demonstrating that social projects, especially healthcare and education, can be advanced through improved information infrastructure, international technical cooperation and multilateral agencies must collaborate with national and international authorities and experts to demand that funding institutions finance projects in such areas. Consistent to these objectives, governments must demand that international and multilateral agencies must promote and support technical cooperation activities in the development of e-health, primarily involving the transfer of knowledge, technical support, facilitation of the exchange of

experiences between countries, and fostering the use of appropriate technology and knowledge assets.

Increasing the general population capacity to take advantage of information and communication technologies requires heavy investment in general education and capacitation in computer skills. A serious problem for non-English speaking countries is that most of the internet is directed to native speakers of English and most sites and exchanges are carried out in that language. Even physicians, who generally have a working knowledge of English, may have problems with such sites. This means that investment is required to develop applications, user interfaces, and contents in national languages.

References

- 1 Mitchell, J. (1999) *From Telehealth to E-health: the Unstoppable Rise of E-health*, Canberra, Australia: National Office for the Information Technology. Available from: http://www.noie.gov.au/projects/ecommerce/ehealth/rise_of_ehealth/unstoppable_rise.htm
- 2 Mitchell, J. (2000) 'Increasing the cost-effectiveness of telemedicine by embracing e-health', *J Telemed Telecare*, Vol. 6, Suppl. 1, pp.S16-19.
- 3 Hagland, M. (2001) 'Finding the e in healthcare', *Healthcare Informatics*, November, pp.21-26.
- 4 Eysenbach, G. (2001) 'What is e-health?', *J Med Internet Research*, Vol. 3, No. 1, p.20. Available from: <http://www.jmir.org/2001/2/e20/index.htm>.
- 5 Della Mea, V. (2001) 'What is e-health (2): the death of telemedicine?', *J Med Internet Research*, Vol. 3, No. 2, p.22. Available from: <http://www.jmir.org/2001/2/e22/index.htm>.
- 6 Pan American Health Organization (1996) *Health Sector Reform: Proceedings of a Special Meeting*, ECLAC/IBRD/IDB/OAS/PAHO/WHO/UNFPA/UNICEF/USAID, Washington, DC, September 29-30.
- 7 Pan American Health Organization (1998) *Information Systems and Information Technology in Health: Challenges and Solutions for Latin America and the Caribbean*, Health Services Information Systems Program, PAHO/WHO, Washington, DC; ISBN 92 75 12246 6.
- 8 US Department of Commerce (2000) 'Leadership for the new millennium: delivering on digital progress and prosperity', *The US Government Working Group on Electronic Commerce, Third Annual Report*, Washington D.C. Available from: <http://www.ecommerce.gov/ecomnews/ecommerce2000annual.pdf>.
- 9 Digital Opportunity Task Force (2001) 'Digital opportunities for all: meeting the challenge', *Report of the DOT Force 11 May 2001*. Available from: http://www.dotforce.org/reports/DOT_Force_Report_V_5.0h.pdf
- 10 Goldstein, A. and O'Connor, D., Organization for Economic Cooperation and Development (2000) 'E-commerce for development: prospects and policy issues', *Technical Papers No. 164*, OECD Development Centre, Paris, France; Publication CD/DOC(00)8. Available from: <http://www.oecd.org/dev/publication/tp/tp164.pdf>.
- 11 Pan American Health Organization (1999) 'Setting up healthcare services information systems: a guide for requirement analysis, application specification, and procurement', Essential Drugs and Technology Program, Division of Health Systems and Services Development. PAHO/WHO, Washington, DC; ISBN 92 75 12266 0.
- 12 Rodrigues, R.J. (2000) 'Telemedicine and the transformation of healthcare practice in the information age', in *Speakers' Book of the International Telecommunication Union (ITU) Telecom Americas 2000*; Telecom Development Symposium, Session TDS.2; Rio de Janeiro, April 10-15, pp.91-105.

- 13 Pan American Health Organization (2001) 'Information technology in the health sector of Latin America and the Caribbean: challenges and opportunities for the international technical cooperation', Essential Drugs and Technology Program, Division of Health Systems and Services Development. Washington D.C.
- 14 Rodrigues, R.J. (2000) 'Information systems: the key to evidence-based health practice', *Bull World Health Org*, Vol. 78, No. 11, pp.1344–1351.
- 15 DOT Force (2001) 'Okinawa charter on global information society', *Official Documents of the Kyushu-Okinawa Summit Meeting*, Available from: <http://www.dotforce.org/reports/it1.html>.
- 16 ECLAC (2000) 'Latin America and the Caribbean in the transition to a knowledge-based society: an agenda for public policy', document prepared by the secretariat of the U.N. Economic Commission for Latin America and the Caribbean for the Regional Meeting on Information Technology for Development, Florianópolis, Santa Catarina, Brazil 20–21 June. Document ECLAC LC/L.1383.
- 17 Chandrasekhar, C.P. and Ghosh, J. (2001) 'Information and communication technologies and health in low income countries: the potential and the constraints', *Bull World Health Org*, Vol. 79, No. 9, pp.850–855.
- 18 US Department of Commerce (1999) *Falling Through the Net: Defining the Digital Divide*, Washington, D.C.: National Telecommunications and Information Administration. Available from: <http://www.ntia.doc.gov/ntiahome/fttn99/contents.html>.
- 19 US Department of Commerce (2002) 'A nation online: how Americans are expanding their use of the internet', Washington, D.C.: Economics and Statistics Administration and National Telecommunications and Information Administration, February. Available from: http://www.ntia.doc.gov/ntiahome/dn/Nation_Online.pdf.
- 20 Ishaq, A. (2001) 'On the global digital divide', *Finance & Develop*, Vol. 38, No. 3, September. Available from: <http://www.imf.org/external/pubs/ft/fandd/2001/09/ishaq.htm>.
- 21 Alcántara, C.H. (2001) 'The development divide in a digital age: an issues paper', United Nations Research Institute for Social Development, Technology, Business and Society Programme Paper Number 4, August; Geneva. ISSN 1020 8216. Available from: <ftp://ftp.unric.org/unricd/outgoing/pp/tbs/hewitt.pdf>.
- 22 World Health Organization (1998) 'A health telematics policy in support of WHO's health-for-all strategy for global health development', *Report of the WHO Group Consultation on Health Telematics*, Dec 11–16, 1996. Publication WHO/DGO/98.1.
- 23 Casas, J.A. (2001) *Trade in Health Services (THS) in the Americas: Trends and Opportunities*, Division of Health and Human Development, Pan American Health Organization, Washington D.C.
- 24 PC Magazine (2001) 'Biz STATS: you'll need to pay to play in e-marketplaces', Internet Business, Special Report e-Business, July Issue, p.5.
- 25 National Coordination Office for Information Technology Research and Development (1999) 'Information technology for the twenty-first century: a bold investment in America's future', White House Office of Science and Technology Policy and the National Science and Technology Council, Executive Office of the President of the USA. Available from: <http://www.ccic.gov/archive/it2/initiative.pdf>.
- 26 World Bank (2001) *World Development Indicators 2001*, Washington, D.C.: The World Bank Development Data Center, ISBN 0 8213 4898 1.
- 27 OECD/UN/UNDP/World Bank (2001) 'Joint global forum: exploiting the digital opportunities for poverty reduction', OECD, Paris, 5–6 March. Available from: <http://www.oecd.org/dac/digitalforum/>.

- 28 ECOSOC (2000) 'Development and international cooperation in the twenty-first century: the role of information technology in the context of a knowledge-based global economy', Draft ministerial declaration of the high-level segment submitted by the President of the United Nations Economic and Social Council, 11 July. Document ECOSOC E/2000/L.9. Available from: <http://www.un.org/documents/ecosoc/docs/2000/e2000-19.pdf>.
- 29 PricewaterhouseCoopers (2000) 'E-connectivity producing measurable results', *HealthCast 2010| E-Health Quarterly*, November, pp.1–23.
- 30 Martínez, A., Rodrigues, R.J., Infante, A., Campillo, C. and Gattini, C. (2001) 'Bases Metodológicas para Evaluar la Viabilidad y el Impacto de Proyectos de Telemedicina', Universidad Politécnica de Madrid y Organización Panamericana de la Salud. Washington D.C., p.138, ISBN 92 75 32363 1.
- 31 Yaffe, J. (2001) 'The internet transformation of business infrastructure', *Research Digest*, Vol. 4, No. 5, Cambridge, MA: Giga Information Group Inc.
- 32 Correa, C.M. (2000) *Intellectual Property Rights, the WLO and Developing Countries: The TRIPS Agreement and Policy Options*, London: Zed Books Ltd, ISBN 1-85649 737 2.
- 33 National Research Council (2001) *Toward a Health Statistics System for the 21st Century: Summary of a Workshop*, Committee on National Statistics, E.B. Perrin, W.D. Kalsbeek and T.M. Scanlan (Eds.) Division of Behavioral and Social Sciences and Education, Washington, D.C.: National Academy Press, ISBN 0-309-07582-3
- 34 Institute of Medicine (2001) *Crossing the Quality Chasm: A New Health System for the 21st Century*, Committee on Quality of Health Care in America, Institute of Medicine, Washington, D.C.: National Academy Press, ISBN 0 309 07280 8.
- 35 Fortune Magazine (2001) 'Building a virtual infrastructure for health care', Special Section on Health Care, March 19.
- 36 Eng, T.R. and Gustafson, D.H. (Eds.) (1999) *Wired for Health and Well-Being – The Emergence of Interactive Health Communication*, US Department of Health and Human Services: Science Panel on Interactive Communication and Health, Office of Public Health and Science, Washington, D.C.: US Printing Office.
- 37 Rodrigues, R.J., Wilson, P. and Schanz, S.J. (2001) 'The regulation of privacy and data protection in the use of electronic health information: an international perspective and reference source on regulatory and legal issues related to person-identifiable health databases', Essential Drugs and Technology Program, Division of Health Systems and Services Development, PAHO/WHO, Washington, DC; ISBN 92 75 12385 3.
- 38 Impicciatore, P., Pandolfini, C., Casella, N. and Bonati, M. (1997) 'Reliability of health information for the public on the world wide web: systematic survey of advice on managing fever in children at home', *Brit Med Journal*, Vol. 314, pp.1875–1878.
- 39 Silberg, W.M., Lundberg, G.D. and Musacchio, R.A. (1997) 'Assessing, controlling, and assuring the quality of medical information on the internet: caveat lector et viewer – let the reader and viewer beware', *JAMIA*, Vol. 277, pp.1244–1245.
- 40 Kiley, R. (1998) 'Consumer health information on the internet', *J Royal Soc Med*, Vol. 91, pp.202–203.
- 41 Boulding, M. and Mack, J. (1998) *Promoting the Benefits of the Web: The Internet Healthcare Coalition*. Available from: http://www.ihealthcoalition.org/content/articles_1.html.
- 42 Eysenbach, G., Diepgen, T.L., Muir Gray, J.A., Bonati, M., Impicciatore, P., Pandolfini, C. and Arunachalam, S. (1998) 'Towards quality management of medical information on the internet: evaluation, labelling, and filtering of information', *Brit Med Journal*, Vol. 317, pp.1496–1502.
- 43 Dyer, K.A. (1999) 'The internet as an untapped medium of medical web-education: a physician's perspective', *The CyberMed Catalyst*, Issue 1. Available from: http://www.amp.org/catalyst/cc_space.htm.

- 44 Adelhard, K. and Obst, O. (1999) 'Evaluation of medical internet sites', *Methods Inf Med*, Vol. 38, No. 2, pp.75–79.
- 45 California HealthCare Foundation (2000) 'Ethics survey of consumer attitudes about health web sites. A report sponsored by the California HealthCare Foundation and the Internet Healthcare Coalition, conducted by Cyber Dialogue in cooperation with the Institute for the Future', *EHealth Reports*, January.
- 46 Rodrigues, R.J. (2000) 'Ethical and legal issues in interactive health communications: a call for international cooperation (Editorial)', *Journal of Medical Internet Research*, Vol. 2, No. 1, March. Available from: <http://www.jmir.org/2000/1/e8/index.htm>.
- 47 California HealthCare Foundation (2001) *Proceed with Caution: A Report on the Quality of Health Information on the Internet*, Oakland CA: CHCF, ISBN 1 929008 61 9.
- 48 Berland, G.K., Elliott, M.N., Morales, L.S., Algazy, J.I., Kravits, R.L., Broder, M.S., Kanouse, D.E., Muñoz, J.A., Puyol, J.A., Lara, M., Watkins, K.E., Yang, H. and McGlynn, E.A. (2001) 'Health information on the internet: accessibility, quality, and readability in English and Spanish', *JAMA*, Vol. 285, No. 20, pp.2612–2621.
- 49 Risk, A. and Dzenowagis, J. (2001) 'Review of internet health information quality initiatives', *Journal of Medical Internet Research*, Vol. 3, No. 4, December. Available from: <http://www.jmir.org/2001/4/e28/index.htm>.

Bibliography

Table 1 and Figure 1

International Telecommunication Union (2002) *World Telecommunication Indicators Database, Chronological Time Series 1960–2001*, CD-ROM, 6th edn, Geneva.

Tables 2 and 5

World Bank (2002) *World Development Indicators*, Development Data Group CD-ROM Edition, 1st edn June 2002, Washington D.C.

Table 3

Harte-Hanks (2001) *CI Technology Database*, Harte-Hanks Market Intelligence, a fee-based Web data service at URL <http://accessCI.hartehanksmi.com>

Table 4

Pan American Health Organization (1998) *Health in the Americas*, Vol. 1, Scientific Publication No. 569, Washington, DC: PAHO/WHO, ISBN 92 75 11569 9.

Table 6

Rodríguez, F. and Wilson, E. (2000) *Slide Presentation at InfoDev Meeting*, Washington, DC: World Bank.