Drivers of the eHealth transformation: beyond age and BMI

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Abstract

Purpose: To recognize the major trends driving development of connected healthcare devices in eHealth environment by 2030.

Methods: Two phase search in commonly used open search engines. First we used regular Google search to find recent policy reports, consensus summaries and expert presentations. Then evidence regarding the recognized trends was sought using Google Scholar.

Results: Statistics backing the often-cited trends of increasing cost of illness, potential for widening health inequality, and increasing need for health information exchange can be found.

Conclusions: The focus of communication technologies in healthcare for connected devices should be on security in novel environments such as WBANs. However, the role of barriers of adoption may be greater than that of the drivers presented here.

Keywords: telemedicine, information systems, forecasting

Introduction

It is well known that the ageing population (Fig. 1) and obesity epidemic [1] will place an increasing burden on our health care infrastructure and spending in the coming years, and new eHealth applications are hoped to help manage this change [2]. Other drivers of increasing eHealth use are less discussed.

Summary publications of driving forces are generally based on mapping expert opinions. Ackerman et al have discussed on developing next generation telehealth tools, and based on expert opinion, recognized some major trends [3]. Haselkorn et al published a summary of the future of remote health services based on expert panel discussion [4]. Heinzelmann et al wrote about telemedicine in the future as a result of human factors, economics and technology [5]. We were interested to further investigate written resources that describe emerging, even still weak trends in an extended time period.
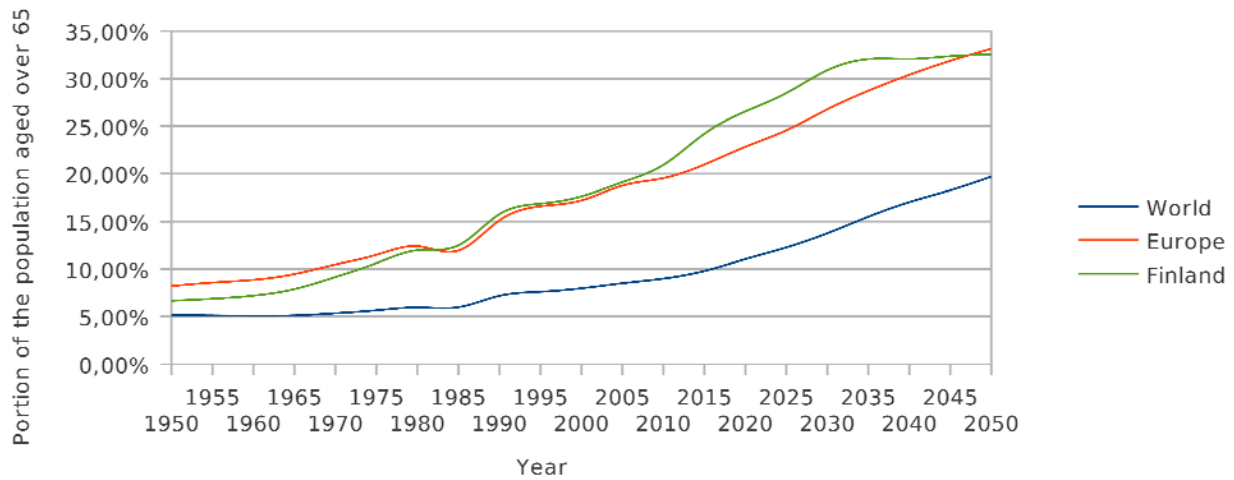
Figure 1. Projected portion of the population older than 65 years at selected geographical locations. Source: United Nations, World Population Prospects 2010.

The survey of literature was performed as part of the background research of the Information processing and transmission chain in medical application (ICMA) project, the goal of which was to evaluate communication technologies in body sensors and connected healthcare devices. The purpose of this survey was to document the often-cited major drivers and technological enablers for use of telecommunications in healthcare and their evidence-based background, to better direct the research effort. The timeline we chose was the year 2030, as the often-cited 17-year time lag in translational research [6] suggests that the solutions are likely to be emerging at this time. It is also around this time that the maintenance ratio in Finland is expected to reach its peak and plateau [7].

Methods

In June-August 2013, we used a regular Google search to search for "health care (2020 OR 2025 OR 2030 OR 2035 OR 2040 OR 2045 OR 2050)" for pages and articles published or edited since 2008. The sources of select policy reports, consensus summaries and expert presentations were examined for commonly accepted megatrends, and a second search using Google Scholar was used to find evidence of specific trends. The results of these searches were not evaluated systematically. Additional Finnish statistics were taken from Statistics Finland.

Results

This first search resulted in over 500 indexed hits, which were evaluated based on search engine summaries. The main sources for trend recognition were the European Health Forum Gastein 2012 presentations [8] and the MovingLife project [9]. Secondary searches were performed using keywords such as "climate change health", "mhealth", and "health equity". A summary of recognized trends is presented in Table 1.

Table 1. Recognized drivers of the eHealth transformation.

Health care challenge	Trends	Megatrends
Cost of illness	Chronic illness	Aging population
		Lifestyle change
	Economic issues	Ageing population
		Cost of novel treatments
		Cost of personalized medicine
Increasing need for health care information exchange	Specialization	Increasing medical knowledge
		Personalized medicine
	Patient mobility	Urbanization
		Globalization
	Patient as additional actor	Chronic illness
		Personal health
Security at all tiers of communication	Greater need for security	Biofeedback systems and programmable implants
	Additional actors	Cloud computing
		Personal health
	Increasing exposure to traditional security threats	Health information exchange
		RF communication
Increasing health disparity	Subprime functioning groups	Mental illness
		Dementia
	Technological divide in health care	Emphasis on technologically assisted personal health
	Welfare cuts and economic disparity	Ageing population leading to economic decline
Acute conditions and disaster medicine	Vulnerability to infections, heat, cold, and disasters	Ageing population
	Disease vectors spreading to new areas	Climate change
	Potential spread of pandemics	Global mobility
	Environmental disasters	Climate change

These recognized trends are presented below in further detail based on their relevance to the development of communications technologies and wireless applications.

Social drivers

Ageing and increasing prevalence of chronic illness

The increasing prevalence of chronic illness due to the ageing population and lifestyle change is likely to remain the main driver of health care change. With the disparity between working-age population and the amount of care needed, an increased need for healthcare professionals is also expected [10] and improved efficiency becomes necessary.

The declining maintenance ratio also inhibits economic growth; the economic consequences of ageing are still a matter of debate, from rather alarmist to moderate [11] views. The prevalence of dementing conditions [12] requires the extreme usability of interventions targeted at the elderly. The aged population is also vulnerable to infectious diseases and extreme environmental conditions [13].

Environmental change

It has been estimated that 24% of the global burden of disease is caused by environmental factors [14] and that we have already changed our environment to unavoidable health repercussions [15]. Climate change is expected to increase the incidence of environmental disasters, to cause the spread of vector-borne diseases such as malaria to new areas, and to increase malnutrition through its impact on agriculture. The health effects of climate change are likely to be disproportionately focused on developing countries close to the equator [13].

Urbanization, globalization, and mobility

The mobility caused by urbanization and globalization increases the need for health information sharing, both at a national and at an international level. Tele-

healthcare may also bring accessible care to the people remaining in rural areas. These trends are expected to continue [16] and to keep driving the demand for eHealth solutions in care and communication.

Urbanization also constitutes a change in the environment of an individual or population. Exposure to fine particulate matter has been linked to cardiovascular and respiratory mortality [17], potentially adding to the incidence of chronic illnesses.

Traditional telehealthcare: mobile communications

Patient interest in eHealth remains high; in a global 2011 consumer survey, 45%–80% of the adult population in developed countries was interested in telecare for chronic conditions [18]. As other services have increasingly moved online, the pressure for health care providers to enable at least the basic services of making appointments and communicating with caregivers is not diminishing.

The worldwide coverage of mobile phone networks [19] is beginning to be leveraged in eHealth. In developed countries, mobile solutions are increasingly used to supplement e-health services. Notably, in low-income countries, there is a vested interest in utilizing the existing mobile technology infrastructure for health care IT. Mobile communications can also be used to track the spread of infectious disease or coordinate and support relief efforts in caring for disaster victims [20].

Health care consumerism and personal health

The expectations and skill set of the people causing the greatest health care burden in 2030 are certain to vary from those of today. It has been suggested by market researchers that consumers, rather than regional initiatives, may be the primary driver of adopting wireless technologies and remote care in medicine [21]. The middle-aged and older consumers also possess increased wealth (Fig. 2), and a global middle class is emerging [22]. This, in combination with increasing patient demands, is leading to lucrative, competitive consumer markets.
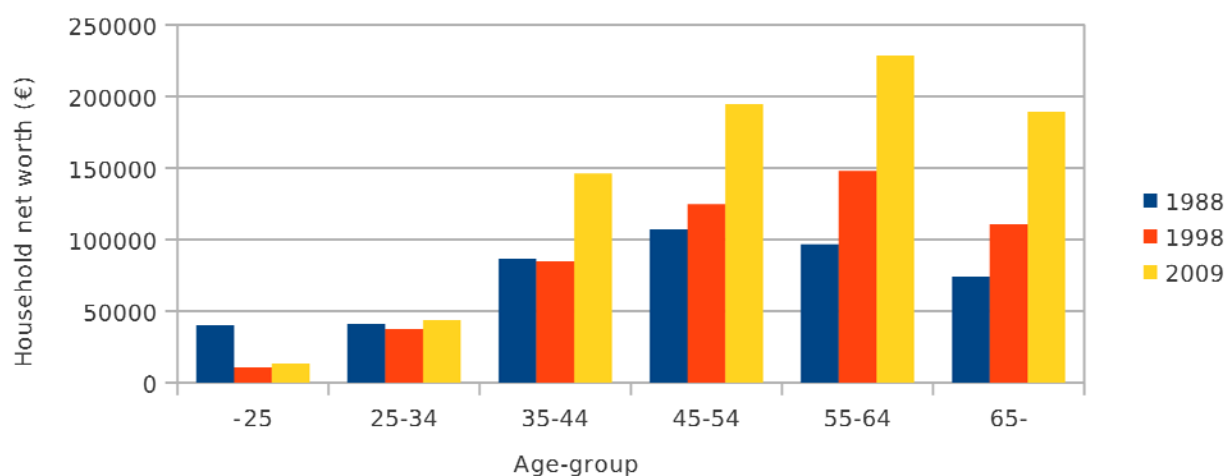
Figure 2. Mean household net worth in Finland by age-group, in year 2009 euros. Source: Statistics Finland: Koti-talouksien varat, velat ja tulot viitehenkilön ikäryhmän mukaan (http://statfin.stat.fi).

Although there is valid concern of direct-to-consumer (genetic) testing of dubious clinical worth [23], most personal health measurements such as blood pressure monitors and glucose meters are well established. To improve their ease of use and reliability of documentation, networked devices are being developed and their standardization is under way [24,25].

The development of personal health devices and systems supports the goals of the chronic care model, which emphasizes patient empowerment and use of information technology [26]. However, in 2010, most personal health record (PHR) systems were still stand-alone products with no communication with electronic health records and patient-entered data only ("untethered") [27], limiting their usability as information repositories in health care. On the other hand, tethered PHRs are often lacking in patient-oriented functionalities [28]. Telehealthcare needs to bridge the gap between consumer and professional.

Personalized medicine, increased data, and cost of care

Personalized medicine is usually linked to genetic and metabolic typing [23], but the availability of other detailed information, including family history, medical history, and data provided by personal health monitoring, also contributes to personalized (Fig. 3) and predictive care [29].

This increasing volume of clinically relevant information places heavy demands on analysis and information management. Communication between systems is needed to enable the implementation of predictive algorithms and clinical decision support systems [23].

Personalized health may also increase the cost of both developing treatments, where new strategies are needed for research in increasingly fragmented potential study populations [30]. This is in addition to the already growing cost of bringing a new drug to market [31].

Risk of uneven benefits and widening health inequality

In many developed countries, a trend of widening health inequality between the well-to-do and the marginalized groups has been recognized [32]. As the patient is given more tools and responsibility for their own health—necessarily due to the nature of chronic illness—the health impact of subprime functioning in populations such as those with mental illness or dementia [12] can be expected to become more pronounced. The technologically assisted interventions

may also compound the effects of the digital divide [33] in health care, especially if financial user investment is required.

Enabling new technologies

Closed loop systems and artificial organs

Systems combining sensors and actuators and implementing feedback loops are increasingly developed and envisioned, as both implantable artificial organs and worn or portable systems [34]. The extreme reliability requirements of such systems are demanding for the security and reliability for the sensor-actuator connection and environmental conditions [35-37]. Such technologically assisted treatments may include remote monitoring and provide new opportunities for follow-up through telecommunications [38].

Cloud computing

Cloud computing is a jargon term referring to remote applications accessed over a network, usually the Internet. This client-server structure enables advantages such as clients on less powerful portable devices, easy deployment, and cross-platform availability. Most definitions further separate true cloud computing from other client-server models by emphasizing resource pooling and dynamic resource optimization [39], which

are not directly visible to the end user but enhance performance.

Private clouds dedicated to or even managed on site by the client organization can exist [39]. However, because of the scalability advantages of cloud computing, the main interest is in outsourced infrastructure made available by an external cloud provider, which may be shared by other clients (public and hybrid clouds); these come with additional security issues related to outsourcing and shared hardware [40].

Taking advantage of cloud computing may help bring down costs, increase availability, and promote mobile solutions of both professional and consumer eHealth services. Future questions are related to the increasing number of competing online health services and the role of outsourced public clouds.

Pervasive computing

Pervasive or ubiquitous computing refers to the distribution of sensing and intelligence into the environment using everyday items such as clothes, vehicles, or furniture. It can be observed in the increasing intelligence in mobile phones, vehicles, or use of radio frequency identification (RFID) tags. Several projects are implementing pervasive computing for assisted living [41].

It is impossible to predict when and how pervasive computing will make its breakthrough. It has the poten-
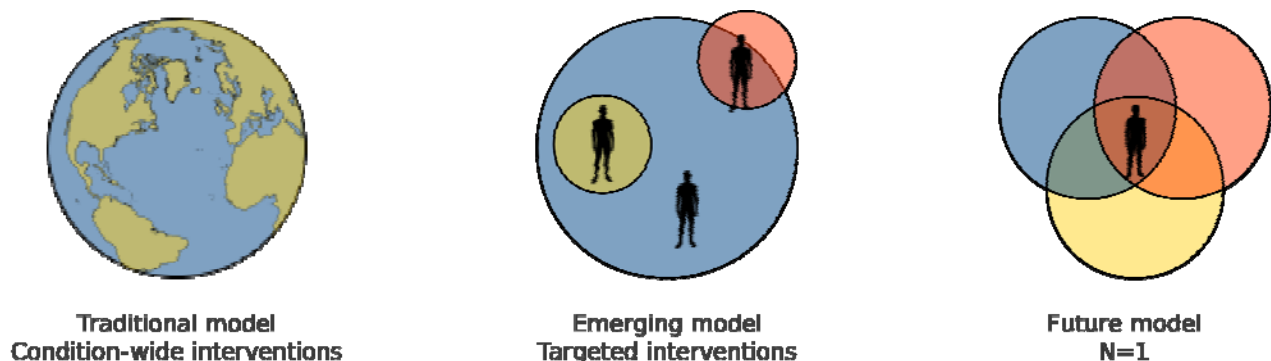

Traditional model
Condition-wide interventions

Emerging model
Targeted interventions

Future model
N=1

Figure 3. From population demographics to personalized health. Loosely adapted from Swan M, "Health 2050: The Realization of Personalized Medicine through Crowdsourcing, the Quantified Self, and the Participatory Biocitizen," Journal of Personalized Medicine 2 (2012):93–118.

tial to profoundly affect the amount of data available on a person's life, the physiological events during an acute situation, or the management of chronic conditions. The spread of intelligent signal transmitting devices will also result in an increasingly a noisy electromagnetic environment. This concerns especially the crowded and increasingly wireless hospitals and in the so-far quiet body area networks.

Augmented reality and novel user interfaces

Augmented reality refers to a live feed of reality augmented by computer-generated sensory input such as visual or auditory cues. This implies ubiquitous real-time information flow back to the user, rather than data of the user to local systems or an external operator. In combination with pervasive computing and context awareness, these new technologies are often envisioned to have medical and assisted living applications, varying from guidance in assisted living [42] to providing information during surgery. [43]

The adoption of augmented reality and novel user interfaces requires the information be present in digital form. It may also increase RF noise levels in the environment.

Other

Several other themes can also be recognized in the literature. Chief among these are severe pandemics and cures to chronic illnesses. Although such events would shift the focus of health care efforts for several years or decades, they are unlikely to occur in the near future.

It should also be noted that the uptake of eHealth has continuously been underwhelming regardless of obvious advantages, expressed demand, and technical capabilities. Commonly cited causes include lack of evidence of cost-effectiveness, poor usability, unsolved regulatory and policy questions, and lack of business models. [9,44,45]

Discussion and conclusions

Much has been written on the subject of future health care and the role of eHealth in it, mainly based on workshops and expert interviews. Although our methodology has been informal, we hope to have presented some data to back these often-cited trends.

The recognized healthcare challenges - cost of illness, need for information exchange and security, disaster management and acute care, and potential for widening health inequality - are all well known, and require both technical and systemic solutions. The role of novel communication technologies in connected devices is limited, and focus in the area should be on improving security, especially in on/in-body communications and noisy environments.

In the larger context in the field of healthcare, the emergence of additional actors in increased patient participation and new data sources increase the need for standard interfaces and information exchange. However, developments in removing the barriers of adoption may be more significant than the drivers we have discussed.

With the social drivers and opportunities provided by new technological developments, the pressure to reshape health care into a technologically assisted multi-actor process in the next 17 years is even greater than it has been in the past.

Acknowledgment

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